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integrating regional and gender perspectives

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A “BEYOND-GDP” APPROACH TO FAIR AND SUSTAINABLE WELL-BEING: INTEGRATING REGIONAL AND GENDER PERSPECTIVES

by Michele Mariani*, Alessandro Pietropaoli** and Tommaso Rughi***

Abstract

This paper investigates the complex nexus between multidimensional well-being and gender equality across Italian regions (2018-2023). We propose a dual analytical framework by constructing two distinct composite indicators from the Istat “equitable and sustainable well-being” (*Benessere equo e sostenibile*, BES) dataset: one measuring overall regional well-being and the other reflecting gender equality after disentangling it from achievement levels. Our analysis yields three key findings. First, we find structural asymmetry: well-being follows a clear North-South divide, while gender equality is geographically fragmented. Second, using Principal Component Analysis (PCA) to analyse both phenomena, we identify five distinct regional groups, highlighting multiple development pathways. Third, a dynamic analysis shows that while well-being displays modest convergence, gender equality does not, indicating gender gaps are not self-correcting. This makes our dual approach essential for designing targeted, place-sensitive policies.

JEL Classification: C38, I31, R10.

Keywords: multidimensional well-being, gender equality, synthetic indices, Italy, regional disparities, equitable and sustainable well-being.

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1 Introduction¹

The critique of gross domestic product (GDP) as an adequate measure of community development is nearly as old as the metric itself (e.g., [Kuznets, 1934](#); [Kennedy, 1968](#)). The recent global shift toward a *Beyond GDP* agenda – catalysed by the Stiglitz-Sen-Fitoussi Commission and embedded in frameworks such as the United Nations’ *Sustainable Development Goals* (SDGs) – rests on a core principle: meaningful societal progress cannot be captured by a single economic metric (e.g., [Stiglitz et al., 2009](#); [United Nations, 2015](#)). Instead, it requires a multidimensional assessment combining material conditions with social, environmental, and institutional aspects of well-being (e.g., [Xu et al., 2020](#); [López-Vizcaíno and Sanchez-Fernandez, 2023](#)). Importantly, distributional concerns have long been recognised as integral to this agenda, reflecting the idea that understanding *who* benefits from progress is as important as measuring progress itself (e.g., [OECD, 2011](#); [Aitken, 2019](#)). This paper contributes to the evolving debate by examining the spatial distribution of multidimensional well-being alongside one specific but highly salient dimension of distributive justice: *gender equality*. By treating *levels* of achievement and *gender gaps* as distinct analytical objects, we address the challenge of integrating societal well-being with gender fairness while avoiding the conflation of average performance and relative disparities.

Common approaches to this integration – whether adjusting well-being levels for gender gaps, as in the *Gender Development Index* (GDI) or *Gender Inequality Index* (GII) (e.g., [Anand and Sen, 1995](#); [UNDP, 2010](#)) or adjusting gender disparities for well-being achievements, as in the *Gender Equality Index* (GEI) (e.g., [Plantenga et al., 2009](#); [Bericat, 2012](#)) – face well-documented conceptual limitations (e.g. [Klasen and Schüler, 2011](#); [Permanyer, 2013](#)). In particular, traditional gender-related indices often blur the boundary between well-being and gender equality, obscuring trade-offs and complicating interpretation ([Beneria and Permanyer, 2010](#)). Our contribution is to propose a dual framework that treats these dimensions as distinct yet interacting phenomena. Specifically, we construct two composite indicators: one capturing average levels of regional well-being, and another capturing a *pure* measure of gender equality, defined as the relative disparity between women and men while disentangled from overall achievement. This sep-

¹We would like to thank Giuseppe Albanese, Silvia Del Prete, Domenico Depalo, Roberto Torrini, Giulia Martina Tanzi, and all the participants at the Bank of Italy internal seminars for their helpful comments and insightful discussions. The views expressed are those of the authors and do not necessarily reflect those of the Bank of Italy.

aration is essential for uncovering the complex and hybrid development trajectories that territories follow.

While the framework we propose is general, we apply it to Italy, a particularly suitable empirical setting. The country exhibits long-standing territorial gaps in economic performance, employment opportunities, public service provision, and broader social outcomes (e.g., Felice, 2019; Viesti, 2021). These divides can be examined thanks to the rich subnational data from the *Benessere Equo e Sostenibile* (BES) initiative, Italy's implementation of the *Beyond GDP* agenda (Istat, 2013). The BES system provides an extensive dashboard of regional indicators, recently expanded to include consistent gender disaggregation across twelve well-being domains. These data reveal that gender inequalities are highly domain-specific: women outperform men in some areas, such as education and health, while facing persistent disadvantages in others, particularly in economic conditions and political representation. This heterogeneity, combined with marked territorial divides, calls for an explicit multidimensional assessment at the subnational level. Although the BES has inspired substantial research on regional well-being (e.g., Alaimo and Maggino, 2020; D'Adamo et al., 2024) and on gender disparities (e.g., Di Bella et al., 2021; Bartiromo and Ivaldi, 2023), these strands have largely developed in parallel. Our dual framework offers a way to analytically integrate them while preserving conceptual clarity.

Empirically, the analysis focuses on the 2018–2023 period, when gender-disaggregated regional data become consistently available, and proceeds in four steps. First, a descriptive exploration documents a pronounced North–South gap in multidimensional well-being, contrasted with a far more fragmented geography in gender equality. Second, a Principal Component Analysis (PCA) uncovers fundamental differences in the latent structures of the two phenomena: while well-being behaves as a largely unidimensional construct, gender equality exhibits a more articulated structure, decomposing into two orthogonal components. This information enables the identification of five distinct regional typologies. Third, a dynamic convergence analysis indicates modest signs of “catch-up” in well-being, but persistent divergence in gender equality, suggesting that gender gaps are not narrowing spontaneously over time. Finally, we evaluate alternative unified indices – including Rawlsian and SDGs-inspired formulations – and show that they mask these asymmetries, reinforcing the case for a dual analytical approach.

The remainder of the paper is structured as follows. Section 2 introduces the framework, data, and methodology. Section 3 presents the empirical results – descriptive, structural, and dynamic. Section 4 discusses the normative implications of unified composite indices. Section 5 concludes.

2 Composite indices for well-being and gender equality

This section details the conceptual and methodological choices underpinning our dual analytical framework.

2.1 Conceptual foundations: defining well-being and gender equality

We define regional well-being as the average level of achievement across the multiple domains of the BES framework. It captures a region’s overall performance, combining objective and subjective dimensions and covering core aspects of life such as health, education, economic conditions, work, social relations, and environmental quality (e.g., [Bacchini et al., 2016, 2021](#)). By contrast, gender equality refers to the relative distribution of these outcomes between women and men within the region. It is a *pure* measure of the gap, conceptually independent of well-being levels. This distinction allows us to disentangle differences in achievement from disparities across genders. Two clarifications are needed. First, our focus is on outcomes rather than opportunities.² While equality of opportunities is a fundamental principle of social justice ([Sen, 1992](#)), its direct measurement is difficult; most empirical work therefore concentrates on achieved outcomes, which provide a pragmatic and comparable basis for analysis. This applies to both gender equality and well-being. Second, our measure of gender equality is non-directional: it captures the magnitude of disparity without assuming which gender is disadvantaged, preventing gaps in opposite directions from cancelling out during aggregation (see, [Klasen, 2006](#); [Permanyer, 2010](#)).

As established in Section 1, maintaining a clear conceptual separation between achievement levels (well-being) and relative disparity (gender equality) is central to our framework. To avoid the conflation

²The equality of opportunities perspective aligns more closely with the concept of gender equity than gender equality ([McDonald, 2013](#)). Gender equity allows for different outcomes if perceived as fair and opportunities are equal. It thus emphasises fairness and access, whereas gender equality refers to strict parity in outcomes.

common in other integrated indices (e.g., GDI, GII, GEI), our dual approach keeps these dimensions distinct, providing clearer insights into both regional achievements and gender gaps.³ Having established this foundation, the normative challenge of integration will be addressed in Section 4.

2.2 Data source and indicator selection

We operationalise regional well-being and gender equality using the latest release of the Istat BES dataset, which provides a comprehensive multidimensional portrait of living conditions in Italy across twelve thematic domains.⁴ Our analysis uses a balanced panel for Italy's 21 NUTS-2 regions and autonomous provinces over 2018-2023, the longest period with consistent gender-disaggregated data across a wide range of indicators, yielding the final dataset of 64 elementary variables.⁵ Compared to the full set of 85 regional indicators available for the general population, our selection excludes those variables where gender breakdowns are either conceptually inapplicable (e.g., *Dry spell days*, *Household access to computer and internet*) or unavailable (e.g., *Crime risk perception*, *Public transport satisfaction*).⁶ A limited number of missing values were imputed using standard procedures.⁷ Selected variables were aligned with the BES domain structure, introducing two minor adjustments.⁸ For analytical robustness, domains were consolidated into five overarching macrodomains: *Economy*, *Education*, *Health*, *Societal*, and *Quality of life*. This level serves as our preferred unit of analysis, striking a balance between informational richness and

³Many users misinterpret integrated indices as simple measures of gender gaps, whereas the achievement dimension often dominates the final score (e.g., Schüler, 2006; Permanyer, 2015). To verify this in our context, we replicated the GEI methodology and decomposed the contributions of achievement and equality components. Results confirm that achievement is not a marginal adjustment for minor inconsistencies, but a dominant factor shaping index values and potentially distorting interpretation. Full details are reported in Appendix A.

⁴The twelve thematic domains – covering areas such as quality of life, social equity and environmental sustainability – are: *Economic well-being*; *Education and training*; *Environment*; *Health*; *Innovation*; *Landscape and cultural heritage*; *Policy and institutions*; *Quality of services*; *Research and creativity*; *Social relations*; *Subjective well-being*; *Work and life balance*.

⁵Although BES regional data exist from 2014, earlier years lack consistent gender detail. Extending the window to 2014-2023 would reduce usable indicators from 64 to 41, weakening key domains for gender analysis such as *Education and training* and *Work and life balance*.

⁶The gender-constrained selection does not distort multidimensional well-being measurement. Appendix B shows that indices based on the 64 gendered indicators capture the same latent information as the full 85-indicator set (overall correlation $\rho > 0.95$), ensuring exclusions do not bias regional rankings.

⁷Missing data points (affecting 11 of the 64 indicators) were handled by: (i) carrying forward the last available value for gaps at the end of a series; (ii) imputing internal gaps as the average of adjacent observations.

⁸The sole *Quality of service* elementary indicator available with both regional and gender detail (*Renouncement of healthcare services*) was reassigned to *Health* for thematic consistency. In addition, the *Health* domain was split into *Health determinants* and *Health status*, following established practices in gender inequality measurement (e.g., Alaimo et al., 2018; Barbieri et al., 2021).

methodological soundness.⁹ Table 1 provides a condensed overview of indicator distribution.

Table 1: Number of elementary indicators within each (macro-)domain.

(Macro-)domain	Number of indicators
Economy	15
Economic well-being	3
Work and life-time balance	12
Education	13
Innovation, research and creativity	3
Education and training	10
Health	10
Health status	5
Health determinants	5
Quality of life	11
Environment	3
Subjective well-being	4
Landscape and cultural heritage	2
Security	2
Societal	15
Policy and institutions	7
Social relations	8
Overall	64

A comprehensive list of all 64 elementary indicators – including their (macro-)domain classification, unit of measurement, polarity, and data sources – is reported in Table 8.

2.3 Index construction: a symmetrical approach

The composite indices are built through a common multi-step procedure, differing only in the definition of their base scores.

For the regional well-being index, which measures overall achievement, base scores W are derived from indicator values for the total population. Since indicators are expressed in different units, they are normalized using a min-max scaling procedure accounting for polarity, a standard practice in composite

⁹Aggregating at the macrodomain level ensures robustness and comparability with related studies (e.g., [Di Bella et al., 2021](#); [Villa et al., 2023](#)). Working at the more granular 12-domain level would pose challenges for statistical reliability given the double disaggregation by region and gender.

indicators design (e.g., [OECD, 2008](#); [Massoli et al., 2014](#)):

$$W_{i,r,t} = \begin{cases} \frac{X_{i,r,t} - \min_{i,t}(X_{i,,t})}{\max_{i,t}(X_{i,,t}) - \min_{i,t}(X_{i,,t})}, & \text{if } i \text{ has positive polarity} \\ \frac{\max_{i,t}(X_{i,,t}) - X_{i,r,t}}{\max_{i,t}(X_{i,,t}) - \min_{i,t}(X_{i,,t})}, & \text{if } i \text{ has negative polarity} \end{cases}$$

where $X_{i,r,t}$ is the original value of indicator i in region r at time t , and $\min_{i,t}(X_{i,,t})$ and $\max_{i,t}(X_{i,,t})$ are the minimum and maximum values observed for that indicator across all regions in that year. Indicators with positive polarity are those where higher values imply better well-being (e.g., the employment rate), while negative polarity indicators are those where lower values are preferable (e.g., perceived environmental degradation).

For the gender equality index, conceived as a "pure" measure of the gender gap, the base score E is instead defined following the European Institute for Gender Equality (EIGE) methodology (e.g., [EIGE, 2017](#); [Humbert and Hubert, 2021](#)):

$$E_{i,r,t} = 1 - \left| \frac{F_{i,r,t}}{A_{i,r,t}} - 1 \right| \quad (1)$$

where $F_{i,r,t}$ is the female value of indicator i in region r at time t , and $A_{i,r,t}$ is the unweighted average of male and female values. This measure ranges from 0 to 1, with 1 indicating perfect equality. The absolute value ensures disparities are captured regardless of which gender is disadvantaged, avoiding offsetting effects when aggregating across indicators. As these scores are already on a standardized scale, no further normalization is required.

Once both base scores are computed, aggregation proceeds identically. Indicator scores are first aggregated into twelve domains using a simple arithmetic mean, which allows some compensability among thematically related measures. Domain scores are then combined into five macrodomains using the geometric mean, which limits the extent to which strong performance in one dimension can mask weaknesses in another. Finally, macrodomain scores are averaged using the arithmetic mean to obtain the

overall composite indices, ensuring balance and transparency.¹⁰

3 Empirical analysis

This section presents our empirical findings, beginning with a static, descriptive analysis of regional disparities, progressing to a structural investigation through PCA, and concluding with a dynamic assessment of recent temporal trends in well-being and gender equality.

3.1 Static and descriptive analysis: a first look at regional disparities

Before examining regional pattern, it may be useful to briefly outline the national structure of gender inequality in Italy. Gender gaps vary widely across domains. The most persistent disadvantages for women occur in economic outcomes and work-life balance: lower wages and pensions, reduced employment rates, and greater exposure to involuntary part-time work. Conversely, gaps reverse in education and skills, where women outperform men in upper secondary and tertiary attainment, and transitions to higher education. In health, longer life expectancy contrasts with limited access to care, yielding near overall parity. Differences are modest in subjective well-being and environmental satisfaction but remain marked in security and especially in political representation. This multidimensional profile shows that gender inequality in Italy is not a single gap but a configuration of domain-specific advantages and disadvantages – an important backdrop for understanding how these patterns manifest at the subnational level.

We now turn to the geography of both well-being and gender equality. Figure 1 visualises the two composite indices across Italian regions, providing an immediate comparative view of their spatial patterns.¹¹ The spatial distribution of the multidimensional well-being index (left map) confirms the well-documented North-South gap, with a stark gradient from the high-performing northern regions

¹⁰The combination of arithmetic and geometric means reflects common practice in composite indicator design, striking a compromise between interpretability and methodological rigour. Robustness checks with alternative normalisation and aggregation schemes, reported in Appendix C, confirm that main results are stable and not driven by specific methodological choices.

¹¹Tables 9 and 10 complement the maps by reporting composite indices for all Italian NUTS-2 regions and NUTS-1 macro-areas, averaged over 2018–2023, together with scores for their respective macrodomains and corresponding rankings (in parentheses). While these tables offer a detailed overview, their density makes it difficult to grasp broad territorial patterns at a glance.

(e.g., Emilia-Romagna, Lombardia and the autonomous provinces of Trento and Bolzano) to the low-scoring southern regions (e.g., Calabria, Campania, and Sicilia). The map for the gender equality index (right map), however, reveals a fundamentally different and more complex geography. The clear North-South divide dissolves, replaced by a fragmented landscape where high well-being does not always align with high gender parity (e.g., Valle d'Aosta, Friuli-Venezia Giulia).

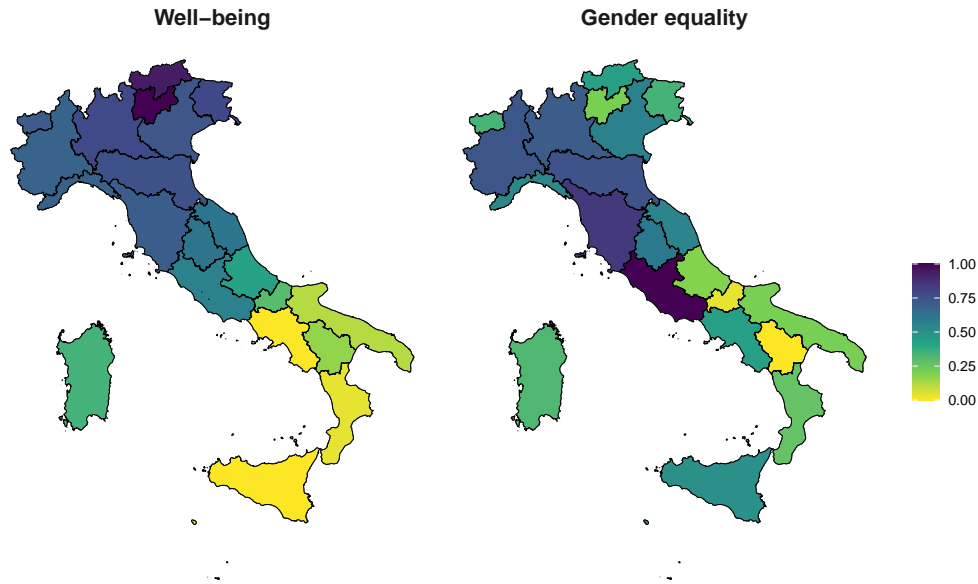


Figure 1: Well-being and gender equality across Italian regions.

This immediate visual divergence suggests different internal structures. To explore relationships *within* and *between* the two concepts, Figure 2 displays the correlation matrix of all macrodomains. Two distinct patterns emerge. Well-being macrodomains (bottom-left triangle) exhibit strong internal coherence, with uniformly high, positive correlations (Kendall’s $W \approx 0.85$). This indicates that regions performing well in one area of well-being tend to excel in others.¹² In stark contrast, gender equality macrodomains (top-right triangle) are fragmented, with weaker correlations, notable trade-offs (e.g., a negative correlation between the *Economy* dimension and *Education, Health* and *Societal* outcomes), and much lower concordance ($W \approx 0.45$). Finally, the block comparing well-being and gender equality

¹²Kendall’s coefficients of concordance are calculated from rankings of both overall composite indices and their respective five macrodomains. They are obtained by summing ranks for each region, computing the variance of these sums, and normalizing the result to obtain a value between 0 (no agreement) and 1 (complete agreement).

(bottom-right square) reveals a mixed picture of both synergies (e.g., *Education, Health, and Societal* macrodomains) and trade-offs (e.g., *Economy and Quality of Life* dimensions).

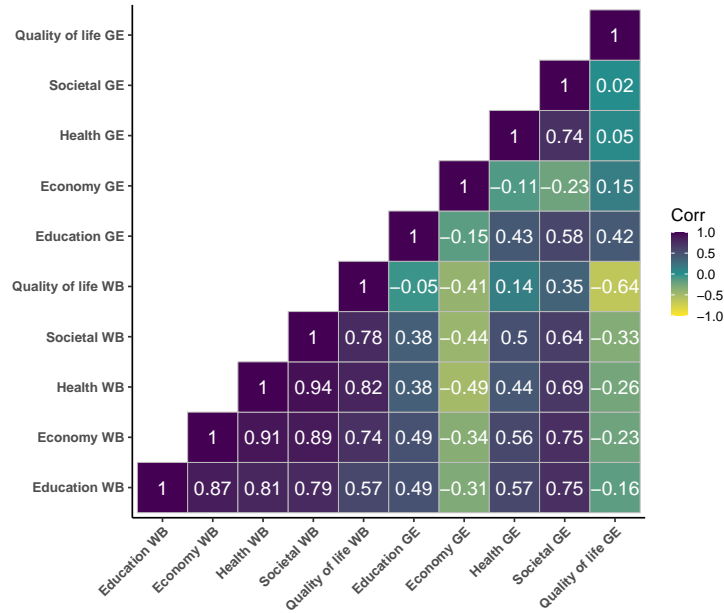


Figure 2: Well-being (WB) and gender equality (GE) macrodomain correlation matrix.

This descriptive analysis yields two key insights. First, regional well-being and gender equality, though related, are distinct phenomena with different geographies. Second, while well-being behaves as a coherent monolithic construct, gender equality is fragmented, with trade-offs across dimensions.

3.2 Uncovering latent structures and regional typologies

The observed patterns suggest that beneath the surface lies a more complex structure that simple descriptive tools cannot fully capture. To probe this latent architecture and better understand regional heterogeneity, we turn to multivariate techniques. Specifically, we apply PCA to reveal the underlying dimensions shaping these disparities, followed by Cluster Analysis to identify regional typologies. Both steps treat well-being and gender equality separately, preserving the dual framework established earlier. For a brief, non-technical explanation of PCA, its diagnostics tests, and clustering methods, see Appendix D.

3.2.1 The primary dimension of regional well-being

We begin by applying PCA to the five well-being macrodomains, averaged over the 2018-2023 period. The data are highly suitable for factor analysis (KMO=0.86; Bartlett's $p < 0.01$). The results, summarised in Table 2 show that the first principal component (PC1) is overwhelmingly dominant, explaining 85.2% of the total variance and being the only one to satisfy the standard retention threshold of 1.0, known as the Kaiser criterion (Kaiser, 1960). Accordingly, only the first principal component is retained for interpretation and further analysis.

Table 2: Well-being principal components.

	PC1	PC2	PC3	PC4	PC5
Standard deviation	2.064	0.674	0.382	0.287	0.237
Proportion of Variance	0.852	0.091	0.029	0.016	0.011
Cumulative Proportion	0.852	0.943	0.972	0.989	1.000
Eigenvalue	4.261	0.455	0.146	0.082	0.056

The interpretation of PC1 is straightforward. As shown in Table 3, all five macrodomains exhibit strong, positive loadings on this component (ranging from 0.85 for *Quality of life* to 0.97 for *Health*). This statistically confirms that regional well-being operates a unified construct: regions performing well in one area tend to perform well across all others. We therefore label PC1 as the "*General index of regional well-being*", where higher scores indicate stronger performance across all five macrodomains.

Table 3: Well-being component loadings (PC1).

	Education	Economy	Health	Quality of life	Societal
PC1	0.876	0.958	0.972	0.845	0.957

This synthetic index provides a clear, data-driven ranking of Italian regions by overall well-being. Figure 3 shows the regional scores, revealing a marked hierarchy. The gap is striking: six points on the standardized scale separate the leaders from the laggards. At the top, Trento and Bolzano form a distinct tier, followed by northern regions and Toscana – the only central region matching northern levels. Around the national average lie the remaining central regions. At the bottom, southern regions – particularly Sicilia, Campania, and Calabria – score markedly lower. This composite index highlights a pronounced

North–South divide, with all positive scores in the North and Centre and all negative ones in the South and Islands. It also offers a single, interpretable metric that will serve as the basis for examining its relationship with regional gender equality in the next stage of our analysis.

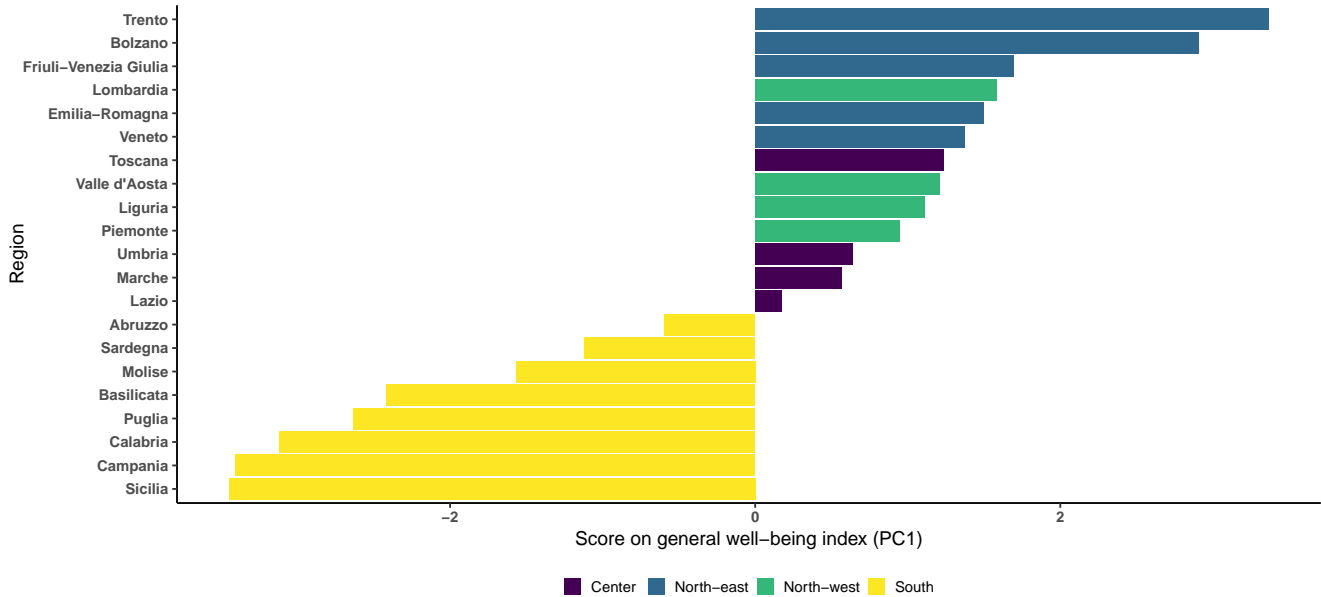


Figure 3: Overall well-being index by region.

3.2.2 The two-fold structure of gender equality

Turning to gender equality, the PCA reveals a more complex, two dimensional structure.¹³

Table 4: Gender equality principal components.

	PC1	PC2	PC3	PC4	PC5
Standard deviation	1.511	1.113	0.935	0.634	0.449
Proportion of Variance	0.457	0.248	0.175	0.080	0.040
Cumulative Proportion	0.457	0.705	0.879	0.956	1.000
Eigenvalue	2.284	1.239	0.874	0.402	0.201

As Table 4 shows, two components satisfy the Kaiser criterion (eigenvalues 2.28 and 1.24), together explaining a substantial 70.5% of the total variance. This finding statistically confirms that regional gender equality is not a monolithic phenomenon but comprises at least two distinct uncorrelated dimensions,

¹³Standard diagnostic tests indicate that data are broadly suitable for factor analysis (KMO=0.56; Bartlett's $p < 0.01$).

whose loadings are reported in Table 5. PC1, explaining 45.7% of the variance, shows strong positive loadings for *Societal* (0.90), *Health* (0.82), and *Education* (0.80). In contrast, *Economy* loads negatively (−0.29). We label this dimension the "*Human development and societal gender equality index*", characterising regions with high gender parity in basic capabilities and social inclusion, even if economic equality lags. PC2, further accounting for 24.8% of the variance, represents a distinct dimension. It loads strongly on *Quality of life* (0.85) and *Economy* (0.58), with mild negative loadings for *Societal* (−0.21) and *Health* (−0.16). This pattern suggests regions where gender equality in material conditions and well-being coexists with lower parity in social and health domains. We term this component the "*Economic and subjective gender equality index*".

Table 5: Gender equality component loadings (PC1 and PC2).

	Education	Economy	Health	Quality of life	Societal
PC1	0.804	-0.290	0.821	0.275	0.897
PC2	0.316	0.585	-0.162	0.853	-0.208

Figure 4 plots these two dimensions, with colours marking geographic macro-areas. The scatterplot shows that gender equality patterns are more complex than the North–South divide seen in overall well-being.

Broad trends remain: Southern regions (yellow) cluster to the left, reflecting lower *Human development and societal gender equality* (PC1), but vary vertically, indicating differences in *Economic and subjective gender equality* (PC2). Northern and Central regions mostly occupy the right side, yet exceptions emerge: Friuli-Venezia Giulia and Valle d’Aosta show unexpectedly low PC1 scores, resembling Southern profiles. Trento and Bolzano, leaders in well-being, fall in the bottom-right quadrant, signalling weaker economic and subjective equality. At the top, Lazio and Piemonte perform well on both dimensions. This heterogeneous picture confirms that geography alone cannot explain gender equality profiles. Regions follow distinct, sometimes surprising paths, with no clear trade-off or synergy between the two dimensions.

3.2.3 Regional typologies: synthesising well-being and equality profiles

We identify regional typologies through hierarchical cluster analysis applied to the three retained principal components: the general well-being (Wb-PC1), the human development/societal gender equality

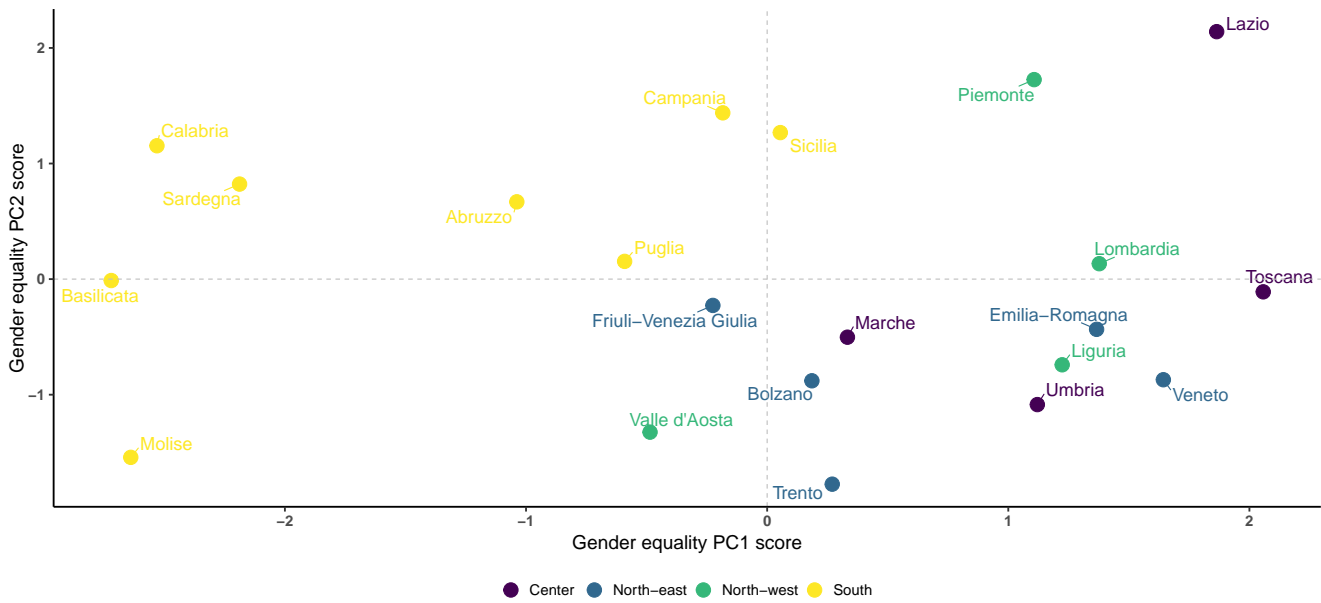


Figure 4: The geography of gender equality.

(Ge-PC1), and the economic/subjective gender parity (Ge-PC2). Standard diagnostics suggest an optimal five-cluster solution, balancing parsimony with explanatory depth, and revealing nuanced regional profiles otherwise obscured. See Appendix E for the full diagnostic plots.

Figure 5 visualises this classification: the x-axis reports Wb-PC1, the y-axis Ge-PC1, and bubble size reflects Ge-PC2. Cluster colours denote the five distinct groupings. The left-side profiles comprise all Southern regions, yet they show different structural challenges. Cluster 1 (purple) includes the so-called *peripheral laggards* (Abruzzo, Basilicata, Calabria, Molise, and Sardegna). These regions exhibit weak human/societal gender equality (low Ge-PC1) and below-average well-being, though their scores remain higher than those of other Southern regions. Abruzzo stands out as a borderline case, approaching national averages across all three dimensions. The *well-being underperformers* (Campania, Puglia, Sicilia) forms Cluster 3 (teal). Despite recording the lowest overall well-being, these regions display relatively stronger gender equality, particularly in economic and subjective dimensions (larger bubbles). This pattern likely reflects male labour-market fragility rather than female advancement – a pattern of "equality trough disadvantage." The remaining three clusters encompass Central and Northern regions, all characterised by above-average well-being, but differing markedly in how this prosperity translates into gender

equality. Cluster 2 (dark blue) brings together the *advanced but unequal regions* (Emilia-Romagna, Liguria, Lombardia, Marche, Toscana, Umbria, Veneto). These territories combine excellent well-being and strong societal gender equality with gaps in economic and subjective dimensions, as reflected by smaller bubbles. Marche stands somewhat apart: its scores align more closely with mid-range values than with the group’s leading edge. Lazio and Piemonte – the *balanced achievers* – forms Cluster 5 (yellow). Although not at the top in overall well-being (particularly Lazio), these regions leverage large metropolitan labour markets to pair robust social and institutional inclusion with solid economic equality, offering a more integrated profile. Finally, Cluster 4 (green) groups the *autonomous well-being champions* (Bolzano, Friuli-Venezia Giulia, Trento, Valle d’Aosta). These affluent territories stand out for exceptional well-being but display weaker gender equality, especially in economic participation (very small bubbles). Their configuration suggests a distinct “performance-first” development model, where prosperity advances faster than gender parity, particularly in the economic sphere.

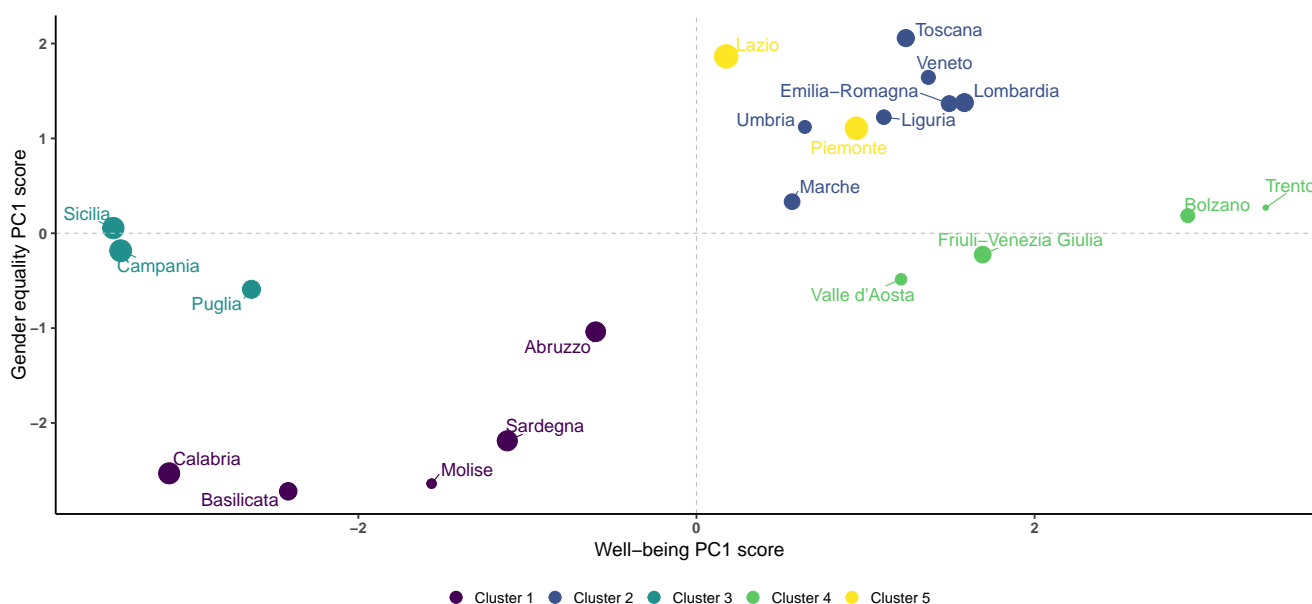


Figure 5: Regional clustering on equitable, sustainable and fair well-being.

Overall, the five-cluster typology highlights the highly differentiated development paths across Italian regions. High well-being does not automatically translate into gender parity, and progress in one equality dimension may coexist with stagnation in another. The relationship between prosperity and inclusion is therefore complex and geographically uneven, underscoring the need for policies tailored to specific

structural profiles rather than broad national prescriptions.¹⁴

3.3 Dynamic analysis: persistence and convergence of regional gaps

Having outlined the structural patterns shaping Italy’s regional landscape, we now adopt a dynamic perspective to examine changes between 2018 and 2023.

We begin with a descriptive overview of the trajectory of the 64 elementary indicators for both well-being and gender equality across regions. Figure 6 classifies regional dynamics as "*improved*", "*stable*" or "*worsen*".

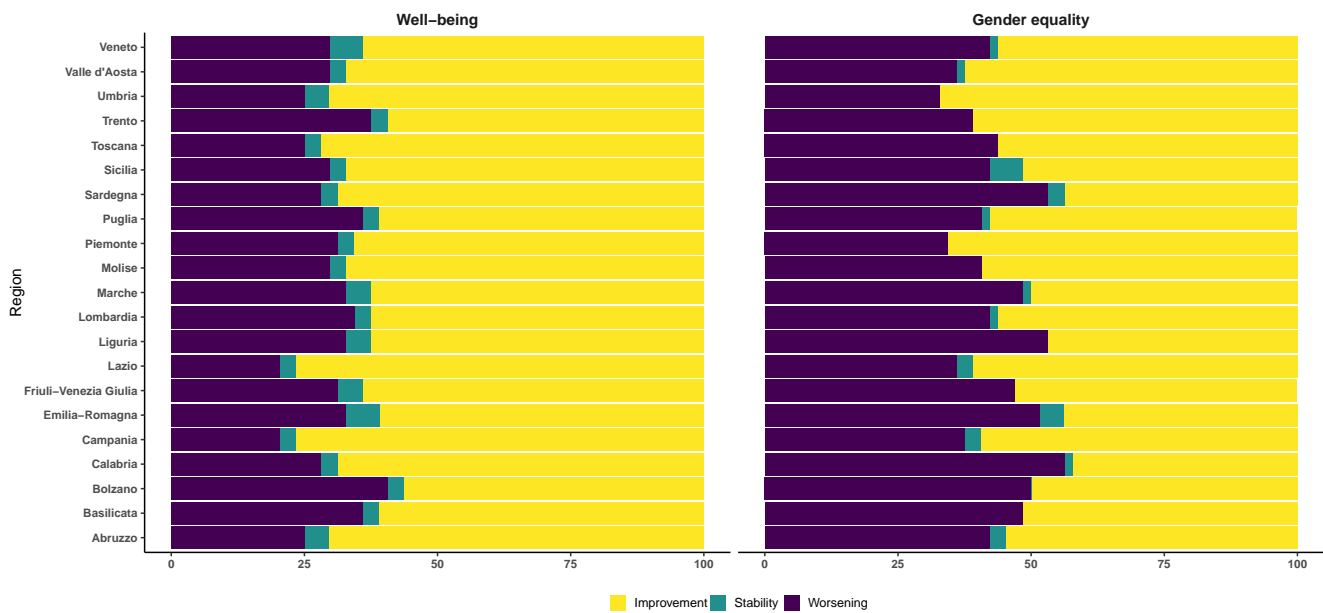


Figure 6: Temporal evolution (2018-2023) of well-being (*Left*) and gender equality (*Right*) elementary indicators by region.

A clear divergence emerges. For well-being (left panel), the picture is one of widespread progress, with improving indicators outnumbering non-improving ones in all regions, with Campania and Lazio showing particularly positive trends. Gender equality (right panel), however, presents a more mixed picture. In several regions – such as Calabria, Emilia-Romagna, and Sardegna – the share of *worsening* or *stable* indicators exceeds that of *improving* ones. This visual evidence suggests that while overall well-being has

¹⁴To validate our findings, a Canonical Correlation Analysis (CCA) is also conducted. It confirms a strong and statistically significant association between well-being and gender equality dimensions (see, Appendix F)

advanced, progress on gender equality has been slower and uneven. These aggregate patterns reflects complex and sometimes divergent trends at the macrodomain level, as detailed in Appendix H.

This descriptive dynamics motivate a more formal analysis to assess whether regional disparities have recently narrowed. To this end, we employ standard convergence tests from the economic growth and development literature (e.g., Felice and Vasta, 2015; Chelli et al., 2023). Specifically, we test for β -convergence (whether lagging regions are "catching up" at a faster rate), σ -convergence (whether the overall dispersion of scores across regions has decreased), and γ -convergence (a non-parametric test of rank stability).¹⁵ Results indicate a slow but significant regional convergence for well-being, holding across most macrodomains except *Health* (Table 6).

Table 6: β , σ and γ convergences.

	β	σ	γ
<i>Well-being</i>			
Education	-0.333***	-0.016***	0.981
Economy	-0.229***	-0.015***	0.997
Health	0.076	0.002	0.948
Quality of life	-0.262***	-0.011**	0.952
Societal	-0.252***	-0.005	0.975
Overall	-0.181***	-0.008***	0.995
<i>Gender Equality</i>			
Education	-0.579***	0.000	0.748
Economy	-0.287**	0.000	0.858
Health	-0.777***	0.001	0.573
Quality of life	-1.245***	0.000	0.466
Societal	-0.099	0.001*	0.868
Overall	-0.237	0.000	0.860

Notes: β and σ are regression estimates. Significance levels: *p<0.1; **p<0.05; ***p<0.01.

The aggregate β -coefficient is negative and highly significant (-0.181^{***}), confirming a "catch-up" dynamic, as visualised in Figure 7 (left panel). This is accompanied by a statistically significant reduction in regional scores dispersion, as evidenced by the negative σ -convergence coefficient (-0.008^{***}). However, the near-one γ -convergence value (0.995) signals gradual convergence without major rank shifts. In stark contrast, gender equality shows fragmented dynamics. While certain domains – *Education*, *Health*, and *Quality of*

¹⁵Methodological details for all convergence tests are provided in Appendix G.

Life – exhibit signs of "catch-up", this pattern does not hold at the aggregate level ($\beta = -0.237$) as illustrated in Figure 7 (right panel). Crucially, we find no evidence of overall σ -convergence: gaps between the best- and worst-performing regions have not narrowed in recent years.¹⁶ Rank stability is also lower than for well-being ($\gamma = 0.860$), with pronounced volatility in *Quality of Life* (0.466) and *Health* (0.573), reinforcing the picture of churning progress.

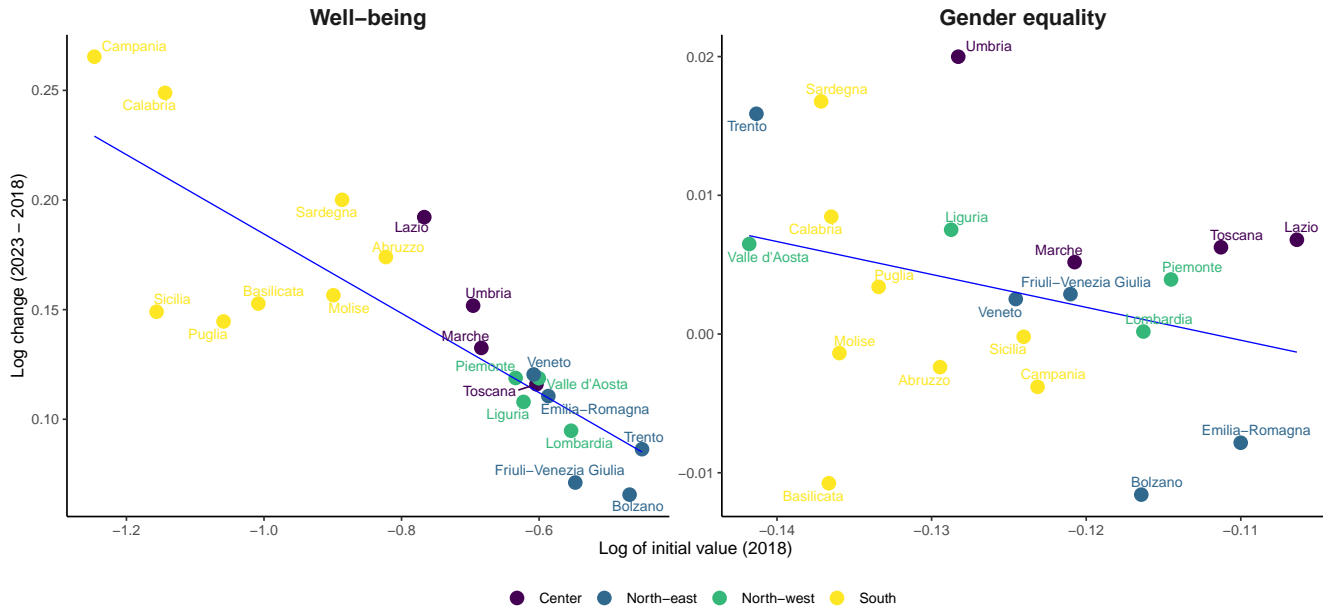


Figure 7: β -convergence analysis for regional indices. Each panel plots the log of initial values (x-axis) against the log change over 2018-2023 (y-axis). Negative slopes indicate β -convergence. *Left:* overall well-being index; *Right:* overall gender equality index.

Taken together, our empirical analyses reveal a fundamental divergence between the dynamics of regional well-being and gender equality. Well-being follows a clear North–South gradient and shows signs of gradual convergence, whereas gender equality remains complex and inconsistent. Structural analysis explains this complexity by identifying five distinct regional typologies – where strong overall performance can coexist with persistent gender gaps. The endurance of these models is confirmed by our dynamic analysis, which finds no evidence of aggregate convergence in gender equality. This suggests that gender disparities will not disappear through general socio-economic progress alone. Targeted,

¹⁶This finding aligns with the well-established notion that β -convergence is necessary but not sufficient for σ -convergence (Sala-i Martin, 1995).

region-specific interventions are therefore essential.¹⁷

4 The normative challenge of a unified index

Our empirical analysis has so far relied on a dual framework, treating regional well-being and gender equality as analytically distinct. This was essential to uncover the complex typologies and nuanced trade-offs that characterise equitable development across Italian regions. However, for policy communication, a single, unified metric is often preferred. This section addresses that normative challenge by testing alternative integration methods aimed at providing gender-sensitive well-being indices.

We explore two conceptually distinct approaches. The first, grounded in Rawlsian principles of social justice (Rawls, 2017), treats gender as a transversal dimension cutting across all aspects of well-being. A region's performance is judged by the outcomes of its disadvantaged gender group, on the premise that societal welfare should be measured by the condition of the least advantaged. We operationalise this idea through two indices: the *Rawlsian minimum well-being index* (RMWI), taking the worse-off gender's value for each indicator, and the *Rawlsian-adjusted well-being index* (RAWI), combining the regional average with the worse-off outcome, weighted by the degree of regional gender inequality.¹⁸ The second approach follows the SDGs logic, where gender equality is treated as a separate pillar rather than a transversal principle. This mirrors the structure of the United Nations' *Sustainable Development Goals*, where Goal 5 stands alongside other goals.¹⁹ We test two variants: the *Well-being index with gender domain* (WB-GD), adding gender equality as a thirteenth domain, and the *Well-being index with gender macrodomain* (WB-GMD), treating it as a sixth macrodomain. Both approaches aim to integrate equity into development measurement, but their normative foundations diverge. Rawlsian logic prioritizes the least advantaged, amplifying structural disadvantage; SDG logic emphasizes comparability and global alignment, but risks

¹⁷To ensure robustness over the five-year period, we conducted a series of leave-one-out checks on both β - and σ -convergence estimates for well-being and gender quality dimensions. Results remain stable regardless of which region is excluded, confirming that findings are not driven by outliers (see Appendix I for full details).

¹⁸The two indices are computed for each indicator i , region r , and year t : $RMWI_{i,r,t} = \min(F_{i,r,t}, M_{i,r,t})$ and $RAWI_{i,r,t} = E_{i,r,t} \cdot A_{i,r,t} + (1 - E_{i,r,t}) \cdot \min(F_{i,r,t}, M_{i,r,t}) = E_{i,r,t} \cdot A_{i,r,t} + (1 - E_{i,r,t}) \cdot RMWI_{i,r,t}$. Here, $F_{i,r,t}$ and $M_{i,r,t}$ denote the values of the indicator for females and males, respectively; $A_{i,r,t}$ represents their unweighted average; and $E_{i,r,t}$ corresponds to the gender equality index as defined in equation 1. The aggregation strategy for the final indices remains consistent with our main approach.

¹⁹See, "Achieve gender equality and empower all women and girls" for more details.

diluting gender concerns by averaging them with dominant well-being dimensions. In short: *equity-first vs. pillar-based integration*.

Table 7 reports scores and rankings for all four methods. Despite their conceptual differences, rankings remain strikingly stable (Spearman rank correlation > 0.98). Minor shifts occur at the margins – e.g., Campania and Sicily swap positions – but the overall hierarchy persists. This stability reflects two mechanisms. For Rawlsian indices, even the disadvantaged gender in high-performing regions often fares better than both genders in lagging regions, preserving the hierarchy. For SDG-inspired indices, the strong signal from well-being domains overwhelms the contribution of the added gender component.

Table 7: Well-being and gender-adjusted indices: scores and rankings by region (2018–2023).

NUTS-2 Regions	Score					Rank				
	WB	RMWI	RAWI	WB-GD	WB-GMD	WB	RMWI	RAWI	WB-GD	WB-GMD
Abruzzo	0.480	0.370	0.456	0.494	0.495	14	14	14	14	14
Basilicata	0.394	0.281	0.368	0.423	0.416	17	17	17	17	17
Bolzano	0.648	0.538	0.626	0.651	0.633	2	2	2	2	2
Calabria	0.351	0.252	0.329	0.387	0.385	19	19	19	19	19
Campania	0.339	0.234	0.319	0.358	0.375	20	21	21	21	21
Emilia-Romagna	0.587	0.485	0.571	0.580	0.588	5	5	5	7	5
Friuli-Venezia Giulia	0.598	0.490	0.578	0.607	0.599	3	4	4	3	3
Lazio	0.524	0.418	0.507	0.511	0.538	13	13	13	13	13
Liguria	0.565	0.459	0.546	0.564	0.567	9	10	9	9	10
Lombardia	0.596	0.492	0.578	0.586	0.598	4	3	3	5	4
Marche	0.540	0.439	0.523	0.549	0.548	12	11	12	11	11
Molise	0.439	0.323	0.415	0.466	0.452	16	16	16	16	16
Piemonte	0.563	0.463	0.545	0.559	0.570	10	9	10	10	9
Puglia	0.377	0.268	0.355	0.398	0.409	18	18	18	18	18
Sardegna	0.454	0.344	0.431	0.479	0.474	15	15	15	15	15
Sicilia	0.338	0.238	0.320	0.369	0.375	21	20	20	20	20
Toscana	0.572	0.473	0.556	0.570	0.578	8	7	7	8	7
Trento	0.670	0.555	0.647	0.671	0.659	1	1	1	1	1
Umbria	0.542	0.433	0.524	0.544	0.547	11	12	11	12	12
Valle d'Aosta	0.576	0.466	0.554	0.593	0.575	7	8	8	4	8
Veneto	0.581	0.477	0.562	0.582	0.587	6	6	6	6	6
Coefficient of variation	0.201	0.254	0.211	0.176	0.170					
Spearman rank correlation						1	0.994	0.996	0.988	0.995

Notes: WB = Well-being index; RMWI = Rawlsian minimum well-being index; RAWI = Rawlsian-adjusted well-being index; WB-GD = Well-being index with gender domain; WB-GMD = Well-being index with gender macrodomain.

Yet while rankings barely move, perceived disparities do. The coefficient of variation rises from 0.201 (WB) to 0.254 (RMWI) under the Rawlsian approach, amplifying gaps. Conversely, SDG-based methods compress disparities (CV= 0.170 for SDG-GMD). Thus, the choice of method shapes how stark – or muted

– territorial divides appear.

Our exercise underscores that integrated indices serve communication and benchmarking, not analytical depth. By merging dimensions, they obscure trade-offs and heterogeneous regional pathways that the dual approach reveals. For policy, however, gender-sensitive measures could enhance accountability and align national strategies with European and global agendas. For research, keeping well-being and gender equality analytically distinct remains a methodological necessity for understanding their complex nexus.

5 Concluding remarks

This paper responds to the global shift toward multidimensional measures of societal progress, moving beyond economic metrics to analyse both the territorial configuration of overall well-being and its distribution *between genders*. Our contribution lies in examining their intersection: the spatial articulation of gender equality within broader regional well-being patterns. We operationalise this through gender-disaggregated BES data for Italy – a country marked by deep territorial divides – over the period 2018–2023.

Three key findings emerge. First, while regional well-being largely reflects a North–South divide, gender equality follows a far more fragmented pattern, shaped by internal trade-offs. Second, our structural analysis identifies five distinct regional typologies that transcend geography, from *peripheral laggards* facing compounded disadvantages to the *autonomous well-being champions* combining top-tier performance with persistent gender gaps. Third, dynamic analysis shows that these divides are structurally persistent: well-being exhibits slow convergence, whereas gender equality does not.

These insights were possible because of the dual analytical framework adopted. Unlike vertical pillars such as *health* or *economy*, gender equality is a transversal dimension cutting across all domains. Treating it as just another pillar – common in unified indices – obscures trade-offs and heterogeneous pathways. Our results confirm that while integrated indices may serve communication purposes, a dual approach is essential for analytical depth.

Policy implications are clear: a "*one-size-fits-all*" strategy will fail. The needs of *challenged* clusters differ fundamentally from those of *autonomous champions*, where the priority is not boosting well-being but addressing gender disparities amid economic success. Effective policy must be place-sensitive and tailored to each regional profile.

Finally, while our analysis is comprehensive, it faces limitations, notably the short time series for gender-disaggregated data. Future research should extend this horizon and refine integrated indices that balance normative clarity with analytical rigour. Having mapped the complex terrain of equitable development, the next step is designing tools that guide policy without sacrificing nuance.

Data availability statement: The data that support the findings of this study are available from the Italian National Institute of Statistics (Istat) at the URL "[Gli indicatori del Bes](#)". The processed dataset used for the analysis is available from the corresponding author upon reasonable request.

6 Tables

Table 8: List of basic indicators.

(Macro-)domain	Variable	Measurement unit	Polarity	Source
Economy				
Economic well-being	Average annual wage of employees	Euro	+	Processing of INPS data
	Average annual per capita pension income	Euro	+	Istat, SSWS
Work-life balance	Pensioners with low pension income	Percentage	-	Istat, SSWS
	Employment rate (20-64 years)	Percentage	+	Istat, LFS
	Rate of non-participation in the labor market	Percentage	-	Istat, LFS
	Youth employment rate (15-29 years)	Percentage	+	Istat, LFS
	Employees in temporary jobs for at least 5 years	Percentage	-	Istat, LFS
	Paid workdays in the year (employees)	Percentage	+	Processing of INPS data
	Over-skilled workers	Percentage	-	Istat, LFS
	Youth non-participation rate (15-29 years)	Percentage	-	Istat, LFS
	Rate of fatal accidents and permanent disability	Per 10,000 employed	-	INAIL
	Perception of job insecurity	Percentage	-	Istat, LFS
	Involuntary part-time employment	Percentage	-	Istat, LFS
Employees working from home	Percentage	+	Istat, LFS	
Satisfaction with work	Per 100 employed	+	Istat, LFS	
Education				
Innovation, research	Knowledge workers	Per 100 employed	+	Istat, LFS
	Cultural and creative occupations	Per 100 employed	+	Istat, LFS
	Regular internet users	Percentage	+	Istat, ADL
Education and training	People with at least a high school diploma	Percentage	+	Istat, LFS
	Transition to university	Cohort-specific rate	+	MoE; MoI
	Early exit from the education and training system	Percentage	-	Istat, LFS
	NEET	Percentage	-	Istat, LFS
	Participation in lifelong learning	Percentage	+	Istat, LFS
	Participation in cultural activities outside the home	Percentage	+	Istat, ADL
	Reading books and newspapers	Percentage	+	Istat, ADL
	Graduates and other tertiary qualifications	Percentage	+	Istat, LFS
	Inadequate numerical competence	Percentage	-	Invalsi
Inadequate literacy competence	Percentage	-	Invalsi	
Health				
Health status	Life expectancy at birth	Average n. of years	+	Life tables
	Healthy life expectancy at birth	Average n. of years	+	Life tables
	Mental health index (SF36)	Average std. scores	+	Istat, ADL
	Life expectancy at 65 years	Average n. of years	+	Life tables and ADL
	Renouncement of healthcare services	Percentage	-	Istat, ADL

Continue on the next page

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(Macro-)domain	Variable	Measurement unit	Polarity	Source
Health				
Health determinants	Overweight	std. rates per 100 persons	-	Istat, ADL
	Smoking	std. rates per 100 persons	-	Istat, ADL
	Alcohol consumption	std. rates per 100 persons	-	Istat, ADL
	Sedentarism	std. rates per 100 persons	-	Istat, ADL
	Adequate nutrition	std. rates per 100 persons	+	Istat, ADL
Quality of life				
Environment	Satisfaction with the environm. situat.	Percentage	+	Istat, ADL
	Concern about biodiversity loss	Percentage	+	Istat, ADL
	Concern about climate change	Percentage	+	Istat, ADL
Subjective well-being	Life satisfaction	Percentage	+	Istat, ADL
	Satisfaction with free time	Percentage	+	Istat, ADL
	Positive outlook on future prospects	Percentage	+	Istat, ADL
	Negative outlook on future prospects	Percentage	+	Istat, ADL
	Cultural heritage	Dissat. with the landscape of the living area	Percentage	-
Security	Concern about landscape degradation	Percentage	+	Istat, ADL
	Safety walking alone in the dark	Percentage	+	Istat, ADL
Security	Elements of degradation in the living area	Percentage	-	Istat, ADL
	Societal			
Policy and institutions	Voter participation	Percentage	+	MoI
	Trust in the Italian Parliament	Average value	+	Istat, ADL
	Female municipal administrators	Percentage	+	Processing of MoI
	Trust in the judicial system	Average value	+	Istat, ADL
	Trust in political parties	Average value	+	Istat, ADL
	Trust in law enforcement and fire services	Average value	+	Istat, ADL
	Women and political represent. at the local level	Percentage	+	Regional Councils
	Social relations	Satisfaction with family relationships	Percentage	+
Social relations	Satisfaction with friendships	Percentage	+	Istat, ADL
	People to rely on	Percentage	+	Istat, ADL
	Civic and political participation	Percentage	+	Istat, ADL
	Volunteering activities	Percentage	+	Istat, ADL
	Funding for associations	Percentage	+	Istat, ADL
	Generalized trust	Percentage	+	Istat, ADL
	Social participation	Percentage	+	Istat, ADL

Notes: Acronyms in "Source" column: Istat: Istituto Nazionale di Statistiche (National Institute of Statistics); SSWS = Social Security and Welfare Statistics; LFS = Labor Force Survey; INPS = Istituto Nazionale di Previdenza (National Institute for Social Security); INAIL = Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro (National Institute for Insurance against Accidents at Work); MoE = Ministry of Education; MoI = Ministry of Interior; Invalsi = Istituto Nazionale per la Valutazione del Sistema Educativo di Istruzione e di Formazione (National Institute for the Evaluation of the Education and Training System).

Table 9: Summary statistics of well-being index and macrodomain indices for NUTS-2 regions and NUTS-1 macro areas (2018-2023).

NUTS-1	NUTS-2	Well-being	Education	Economy	Health	Societal	Quality of life
North-West	Liguria	0.565 (9)	0.551 (10)	0.600 (10)	0.581 (8)	0.558 (4)	0.534 (7)
	Lombardia	0.596 (4)	0.629 (3)	0.719 (1)	0.590 (5)	0.535 (7)	0.507 (13)
	Piemonte	0.563 (10)	0.542 (11)	0.676 (3)	0.570 (10)	0.521 (10)	0.504 (14)
	Valle d'Aosta	0.576 (7)	0.519 (12)	0.620 (8)	0.580 (9)	0.499 (11)	0.660 (3)
North-East	Bolzano	0.648 (2)	0.503 (13)	0.708 (2)	0.669 (2)	0.680 (1)	0.680 (2)
	Emilia-Romagna	0.587 (5)	0.602 (4)	0.661 (4)	0.581 (7)	0.570 (3)	0.523 (10)
	Friuli-Venezia Giulia	0.598 (3)	0.577 (7)	0.656 (5)	0.602 (3)	0.530 (8)	0.626 (4)
	Trento	0.670 (1)	0.674 (2)	0.646 (7)	0.708 (1)	0.637 (2)	0.682 (1)
Centre	Veneto	0.581 (6)	0.578 (6)	0.650 (6)	0.602 (4)	0.523 (9)	0.553 (5)
	Lazio	0.524 (13)	0.678 (1)	0.570 (11)	0.539 (13)	0.475 (13)	0.357 (18)
	Marche	0.540 (12)	0.552 (9)	0.547 (12)	0.565 (11)	0.486 (12)	0.551 (6)
	Toscana	0.572 (8)	0.594 (5)	0.602 (9)	0.588 (6)	0.549 (5)	0.526 (9)
South	Umbria	0.542 (11)	0.565 (8)	0.539 (13)	0.542 (12)	0.546 (6)	0.519 (11)
	Abruzzo	0.480 (14)	0.495 (14)	0.431 (14)	0.513 (15)	0.463 (14)	0.498 (15)
	Basilicata	0.394 (17)	0.405 (17)	0.331 (18)	0.411 (21)	0.392 (17)	0.429 (16)
	Calabria	0.351 (19)	0.298 (21)	0.250 (21)	0.430 (19)	0.383 (18)	0.393 (17)
	Campania	0.339 (20)	0.348 (19)	0.286 (19)	0.417 (20)	0.372 (20)	0.271 (21)
	Molise	0.439 (16)	0.440 (15)	0.403 (16)	0.446 (17)	0.396 (16)	0.508 (12)
	Puglia	0.377 (18)	0.349 (18)	0.338 (17)	0.469 (16)	0.375 (19)	0.353 (19)
	Sardegna	0.454 (15)	0.408 (16)	0.408 (15)	0.515 (14)	0.412 (15)	0.528 (8)
Sicilia	0.338 (21)	0.299 (20)	0.283 (20)	0.432 (18)	0.326 (21)	0.351 (20)	
Italy		0.511	0.521	0.551	0.537	0.482	0.464
NUTS-1 geom. mean	North-West	0.575 (2)	0.559 (3)	0.652 (2)	0.58 (2)	0.528 (2)	0.548 (2)
	North-East	0.616 (1)	0.584 (2)	0.664 (1)	0.631 (1)	0.585 (1)	0.609 (1)
	Centre	0.544 (3)	0.595 (1)	0.564 (3)	0.558 (3)	0.513 (3)	0.481 (3)
	South	0.393 (4)	0.375 (4)	0.335 (4)	0.453 (4)	0.388 (4)	0.407 (4)
Unweighted std. dev.		0.103	0.116	0.156	0.082	0.093	0.112
Coefficient of variation		0.202	0.230	0.300	0.152	0.191	0.223

Notes - Total and macrodomain well-being scores for NUTS-2 regions and NUTS-1 macro-areas, calculated according to the methodology described in Section 2. Regional ranks are reported in parentheses.

Table 10: Summary statistics of gender equality index and macrodomain indices for NUTS-2 regions and NUTS-1 macro areas (2018-2023).

NUTS-1	NUTS-2	Gender equality	Education	Economy	Health	Societal	Quality of life
North-West	Liguria	0.887 (9)	0.892 (7)	0.828 (17)	0.88 (4)	0.902 (11)	0.935 (14)
North-West	Lombardia	0.893 (5)	0.902 (2)	0.840 (12)	0.869 (8)	0.916 (6)	0.937 (9)
North-West	Piemonte	0.894 (3)	0.900 (4)	0.848 (4)	0.869 (8)	0.903 (10)	0.948 (2)
North-West	Valle d'Aosta	0.881 (13)	0.873 (16)	0.840 (12)	0.870 (7)	0.896 (14)	0.928 (20)
North-East	Emilia-Romagna	0.894 (3)	0.876 (15)	0.846 (6)	0.881 (2)	0.930 (1)	0.937 (9)
North-East	Friuli-Venezia Giulia	0.881 (13)	0.887 (8)	0.829 (16)	0.857 (16)	0.897 (12)	0.937 (9)
North-East	Bolzano	0.884 (11)	0.882 (10)	0.834 (14)	0.868 (10)	0.904 (9)	0.933 (18)
North-East	Trento	0.877 (17)	0.878 (13)	0.802 (21)	0.861 (14)	0.910 (7)	0.934 (16)
North-East	Veneto	0.888 (7)	0.902 (2)	0.814 (20)	0.865 (12)	0.923 (3)	0.936 (13)
Centre	Lazio	0.902 (1)	0.907 (1)	0.864 (3)	0.875 (5)	0.918 (4)	0.948 (2)
Centre	Marche	0.888 (7)	0.865 (18)	0.847 (5)	0.881 (2)	0.908 (8)	0.937 (9)
Centre	Toscana	0.897 (2)	0.894 (5)	0.843 (9)	0.882 (1)	0.927 (2)	0.938 (7)
Centre	Umbria	0.889 (6)	0.893 (6)	0.834 (14)	0.873 (6)	0.917 (5)	0.931 (19)
South	Abruzzo	0.876 (19)	0.879 (12)	0.828 (17)	0.854 (18)	0.877 (19)	0.944 (5)
South	Basilicata	0.871 (21)	0.863 (19)	0.845 (8)	0.854 (18)	0.856 (21)	0.934 (16)
South	Calabria	0.879 (16)	0.878 (13)	0.870 (1)	0.848 (20)	0.864 (20)	0.935 (14)
South	Campania	0.884 (11)	0.880 (11)	0.841 (10)	0.866 (11)	0.886 (16)	0.949 (1)
South	Molise	0.872 (20)	0.850 (21)	0.846 (6)	0.855 (17)	0.882 (18)	0.926 (21)
South	Puglia	0.877 (17)	0.873 (16)	0.823 (19)	0.863 (13)	0.883 (17)	0.943 (6)
South	Sardegna	0.881 (13)	0.862 (20)	0.866 (2)	0.848 (20)	0.891 (15)	0.938 (7)
South	Sicilia	0.886 (10)	0.887 (8)	0.841 (10)	0.86 (15)	0.897 (12)	0.946 (4)
Italy		0.898	0.901	0.850	0.871	0.910	0.957
NUTS-1 geom. mean	North-West	0.889 (2)	0.892 (1)	0.839 (3)	0.872 (2)	0.904 (3)	0.937 (3)
	North-East	0.885 (3)	0.885 (3)	0.825 (4)	0.866 (3)	0.913 (2)	0.935 (4)
	Centre	0.894 (1)	0.89 (2)	0.847 (1)	0.878 (1)	0.917 (1)	0.938 (2)
	South	0.878 (4)	0.871 (4)	0.845 (2)	0.856 (4)	0.879 (4)	0.939 (1)
Unweighted std. dev.		0.008	0.015	0.016	0.011	0.020	0.006
Coefficient of variation		0.009	0.017	0.019	0.013	0.022	0.006

Notes: Total and macrodomain well-being scores for NUTS-2 regions and NUTS-1 macro-areas, calculated according to the methodology described in Section 2. Regional ranks are reported in parentheses.

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Appendix A Decomposing the GEI: achievement and equality

We replicate the approach proposed by [Permanyer, 2015](#) – originally applied at the national level – by implementing the GEI methodology on BES data at both the domain and regional levels. This allows us to compare the relative contributions of the achievement and equality components.

Table 11 reports the average contribution of the gender equality component (C_e) across twelve domains and Italian regions.

Table 11: Contribution of the equality component.

Region	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	Overall
Abruzzo	29.5	49.1	26.5	42.5	44.0	35.9	9.6	37.4	25.9	51.7	42.5	36.6	35.9
Basilicata	14.9	38.2	30.9	40.7	37.1	30.6	12.6	38.7	23.9	46.3	39.5	69.0	35.2
Calabria	13.2	25.9	22.8	39.6	23.4	27.3	14.4	42.7	21.0	51.8	38.9	46.7	30.6
Campania	10.2	40.2	26.4	47.2	21.0	30.1	11.5	44.5	16.3	49.1	36.6	25.9	29.9
Emilia-Romagna	27.5	86.2	30.9	63.9	53.0	46.1	13.6	55.1	29.3	53.7	50.8	37.2	45.6
Friuli-Ven. Giulia	26.0	84.4	33.6	49.3	59.7	47.0	27.7	36.6	33.6	58.4	55.2	61.5	47.8
Lazio	14.0	63.9	33.8	90.5	49.4	38.3	7.3	38.8	22.2	52.4	45.0	28.4	40.3
Liguria	26.1	75.7	31.0	53.9	42.2	37.5	20.2	48.0	26.7	52.9	50.6	42.1	42.2
Lombardia	24.3	91.1	38.7	61.5	49.1	55.4	21.2	35.7	26.2	57.6	49.4	34.5	45.4
Marche	19.9	55.1	31.4	51.6	54.6	39.8	22.6	40.8	24.1	52.2	46.8	46.6	40.5
Molise	31.2	38.5	38.1	51.4	39.9	35.1	15.9	41.9	24.3	46.4	44.9	57.5	38.8
Piemonte	16.9	84.8	30.8	48.6	40.5	46.8	14.8	39.3	19.3	60.7	47.1	33.5	40.3
Bolzano	56.1	78.7	63.2	55.4	52.2	82.0	75.6	51.9	74.1	67.8	86.8	47.9	66.0
Trento	57.5	79.6	40.8	70.5	81.0	52.8	62.7	42.8	66.0	78.2	73.4	64.3	64.1
Puglia	12.4	45.6	20.2	42.4	25.4	32.5	13.0	42.9	17.4	51.3	38.2	33.0	31.2
Sardegna	27.8	41.5	44.0	40.1	37.1	30.3	15.6	34.4	22.7	59.1	45.9	47.5	37.2
Sicilia	14.1	41.4	22.0	41.4	21.1	26.6	11.8	37.4	19.0	54.2	35.1	31.9	29.7
Toscana	28.9	72.0	34.5	62.3	42.9	39.6	14.2	45.7	25.4	50.7	51.6	37.4	42.1
Umbria	27.0	61.0	36.4	49.9	52.9	38.0	19.6	61.0	29.9	52.1	52.4	36.8	43.1
Valle d'Aosta	45.9	81.3	33.0	48.9	47.7	36.6	31.2	35.0	37.0	58.0	44.7	88.1	48.9
Veneto	27.6	82.3	32.3	48.2	46.0	53.5	21.1	39.9	26.6	58.1	51.9	40.6	44.0
Italy	12.5	60.5	26.8	46.9	33.8	24.5	6.2	33.2	18.3	52.9	41.2	31.1	33.2
Coef. Var.	30.0	158.7	45.6	98.7	66.2	62.7	23.2	63.5	35.6	117.6	83.2	65.5	62.6

Notes - The domains are labelled as follows: D1: Environment; D2: Economic Well-being; D3: Subjective Well-being; D4: Innovation, Research, and Creativity; D5: Education and Training; D6: Employment and Work-Life Balance; D7: Landscape and Cultural Heritage; D8: Politics and Institutions; D9: Social Relationships; D10: Health Determinants; D11: Health Status; D12: Safety.

The results reveal substantial heterogeneity both across thematic areas and territorial units. The *Landscape and Cultural Heritage* and *Environment* domains display the lowest average contributions from the equality component, whereas *Economic Well-being* and *Health Determinants* record the highest. A general inverse

relationship emerges between interregional variability (measured by the coefficient of variation) and the weight of the equality component: in domains where regional disparities are small, the overall index is largely driven by achievements rather than equality. Strikingly, in 71 percent of cases the contribution of C_e is below 50 percent, meaning that in nearly three out of four instances the achievement factor (α) dominates the index. On average, C_e accounts for just 42 percent across all domains and regions. These results confirm that achievements are not marginal refinements, but decisive drivers of the final index. This finding is not fully coherent with the official GEI guidelines, which explicitly recommend that the equality component should outweigh the correcting factor, both overall and for each country and variable (EIGE, 2017).²⁰

²⁰In the report is literally recommended that: *"It is desirable to have the contribution of gender equality higher than the contribution of the correcting coefficient, overall as well as for every Member State and each variable."*

Appendix B Robustness to indicator selection

We assess whether restricting the indicator set to variables with gender-disaggregated data affects the measurement of regional well-being. Specifically, we compare indices computed from the full set of 85 indicators with those based on the 64 gender-constrained variables. Results show that the reduced set preserves the underlying multidimensional structure, as evidenced by very high correlations at both overall and macrodomain levels (Figure 8). These findings confirm that excluding indicators without gender detail – either conceptually inapplicable or unavailable – does not distort regional rankings or compromise analytical validity.

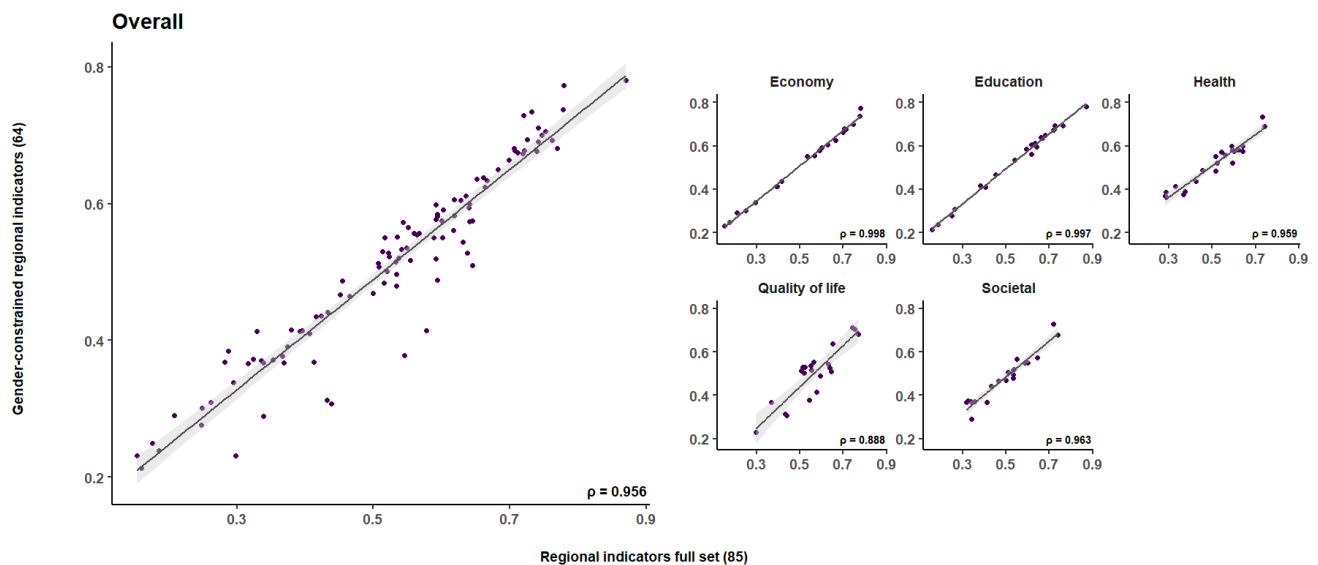


Figure 8: Comparison of regional well-being indices based on two indicator sets: the gender-constrained version (64 indicators) and the full-information version (85 indicators). *Left:* overall regional scores with fitted linear trend and correlation coefficient. *Right:* scatter plots for the five macrodomain scores, each with its correlation coefficient.

Appendix C Robustness checks

To test the robustness of our baseline indices against specific methodological choices (OECD, 2008), we re-calculated the regional rankings using alternative specifications (Mazziotta and Pareto, 2017).

For the well-being index, we tested 16 alternative specifications (combining 4 normalization methods: z-score, min-max, distance-from-best, and Borda score; and 4 different aggregation schemes based on various mix of linear additive average (LAA) and geometric average (GA)). For the gender equality index, which is inherently bounded between 0 and 1, we simply tested 4 alternative aggregation schemes.²¹

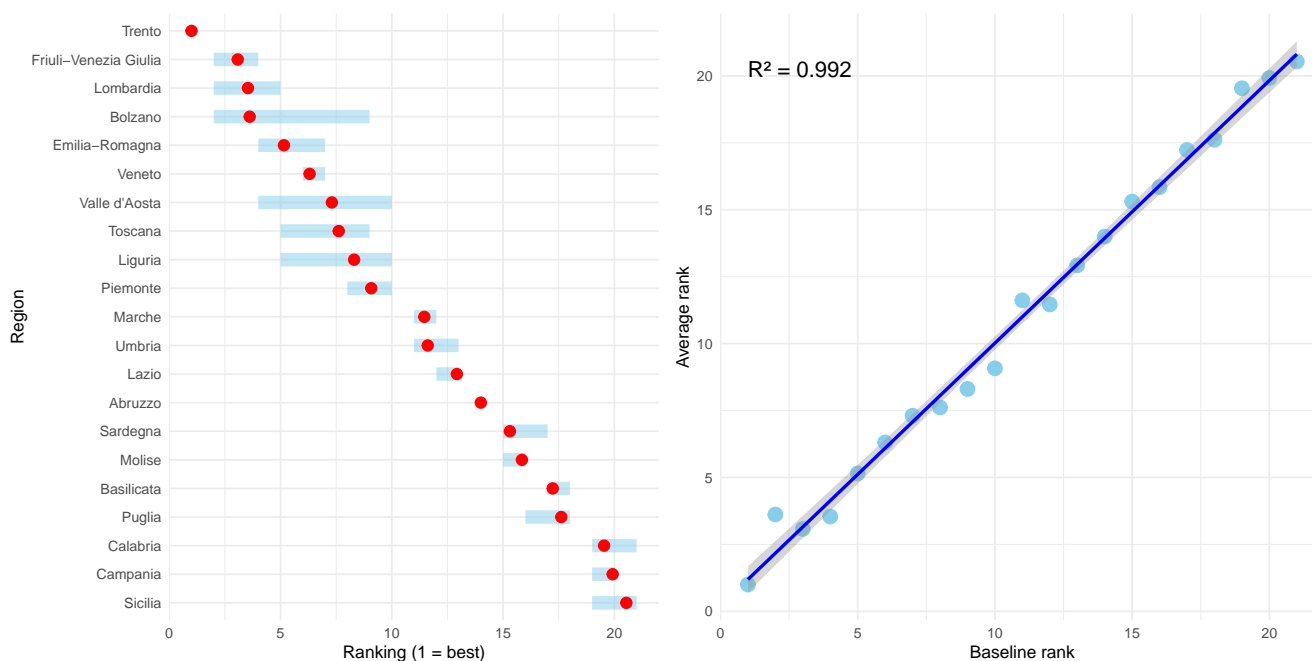


Figure 9: Well-being rankings across methodological specifications. *Left:* distribution of rankings across 16 alternative combinations; the red circles mark the average ranking; *Right:* scatter plot with fitted regression line comparing the baseline ranking with the average ranking.

As summarised in Figures 9 and 10 the results are highly consistent for both well-being and gender

²¹The four alternative aggregation schemes are: (i) LAA at all steps; (ii) LAA at domain level, GA at macrodomain, and LAA at final level (our baseline model); (iii) LAA at domain level and GA at both macrodomain and final levels; and (iv) GA at all steps. To apply the geometric mean, indicators normalized by z-scores and min-max are rescaled to ensure strictly positive values.

equality. The regional hierarchies remain remarkably stable across all specifications (*Left panel*), and the baseline rankings are strongly correlated with the average rankings (*Right panel*; $R^2 > 0.99$). These checks confirm that our main results are robust and not driven by specific methodological choices.

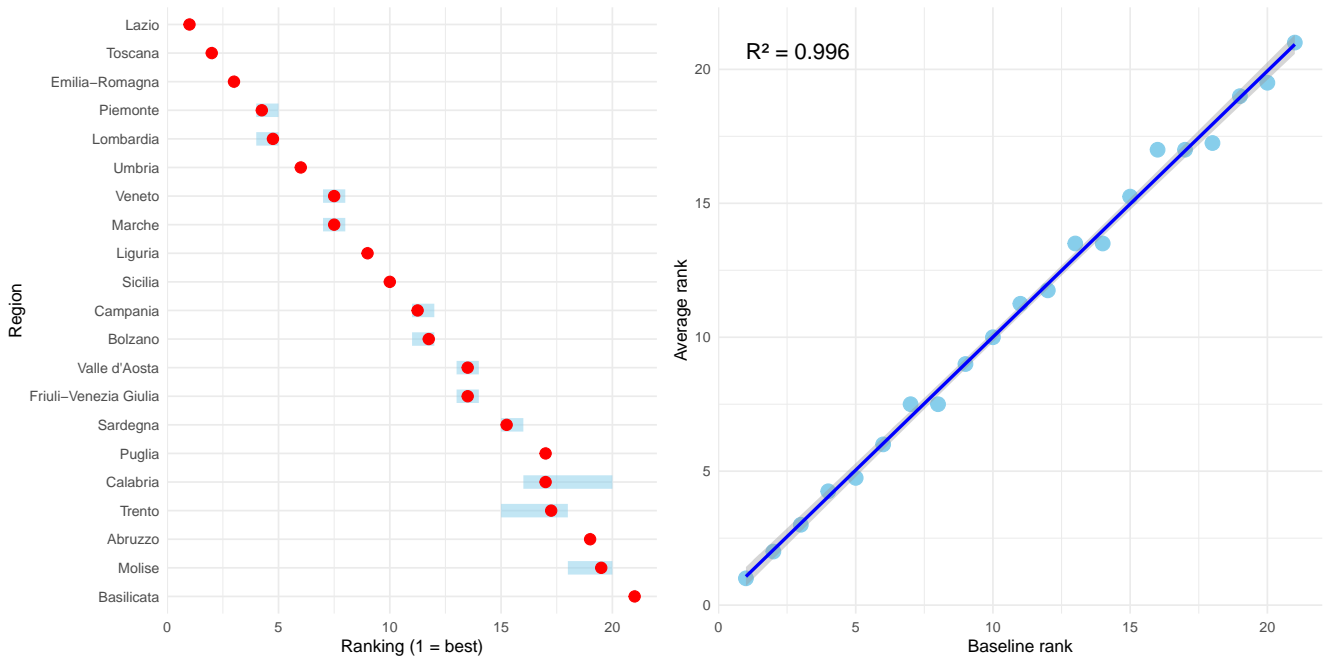


Figure 10: Gender equality rankings across methodological specifications. *Left:* distribution of rankings across 4 alternative combinations; the red circles mark the average ranking; *Right:* scatter plot with fitted regression line comparing the baseline ranking with the average ranking.

Appendix D Non-technical notes on PCA and Cluster Analysis

This appendix provides a brief, non-technical overview of the methods used in Section 3.2.

D.1 Principal Component Analysis (PCA)

PCA is a statistical technique for reducing dimensionality and uncovering patterns in multivariate data (OECD, 2008; Jolliffe, 2011). It transforms correlated variables (e.g., our five macrodomains) into a smaller set of uncorrelated components that capture most of the variance (Hair, 2009). In our study, PCA identifies latent dimensions summarizing regional well-being and gender equality profiles. Before applying PCA, two standard diagnostics usually assess data suitability. The *Kaiser-Meyer-Olkin* (KMO) test measures sampling adequacy. A value greater than 0.5 is commonly accepted as suitable for PCA (e.g., Kaiser, 1970; Dziuban and Shirkey, 1974). The *Bartlett's Test of Sphericity* tests the null hypothesis that the variables are uncorrelated. A significant p-value ($p < 0.05$) confirms sufficient correlation among variables to justify a reduction in their dimensionality (Bartlett, 1937). To decide how many components to retain, we apply the *Kaiser criterion*, keeping only components with eigenvalues > 1.0 (Kaiser, 1960).

D.2 Cluster Analysis diagnostics

Cluster analysis groups regions so that those within a cluster are more similar to each other than to regions in other clusters (Kaufman and Rousseeuw, 1990; Everitt et al., 2011). To select the optimal number of clusters (k), we use standard diagnostic methods. The *elbow method* plots the total within-cluster variance against the number of clusters (k). The "elbow" is the point of diminishing returns, after which adding more clusters provides little new information. The *silhouette method* measures how well each region fits its cluster relative to others. A high average score suggests a good cluster configuration. Finally, the *dendrogram* is a tree diagram that visualizes the full hierarchical clustering, allowing for a qualitative inspection of how groups merge. These diagnostics support the five-cluster solution adopted in the main analysis, balancing parsimony and interpretability (Appendix E).

Appendix E Clustering diagnostics

Various algorithms and heuristics have been proposed for selecting the optimal number of clusters (e.g., [Kaufman and Rousseeuw, 1990](#); [Everitt et al., 2011](#)).

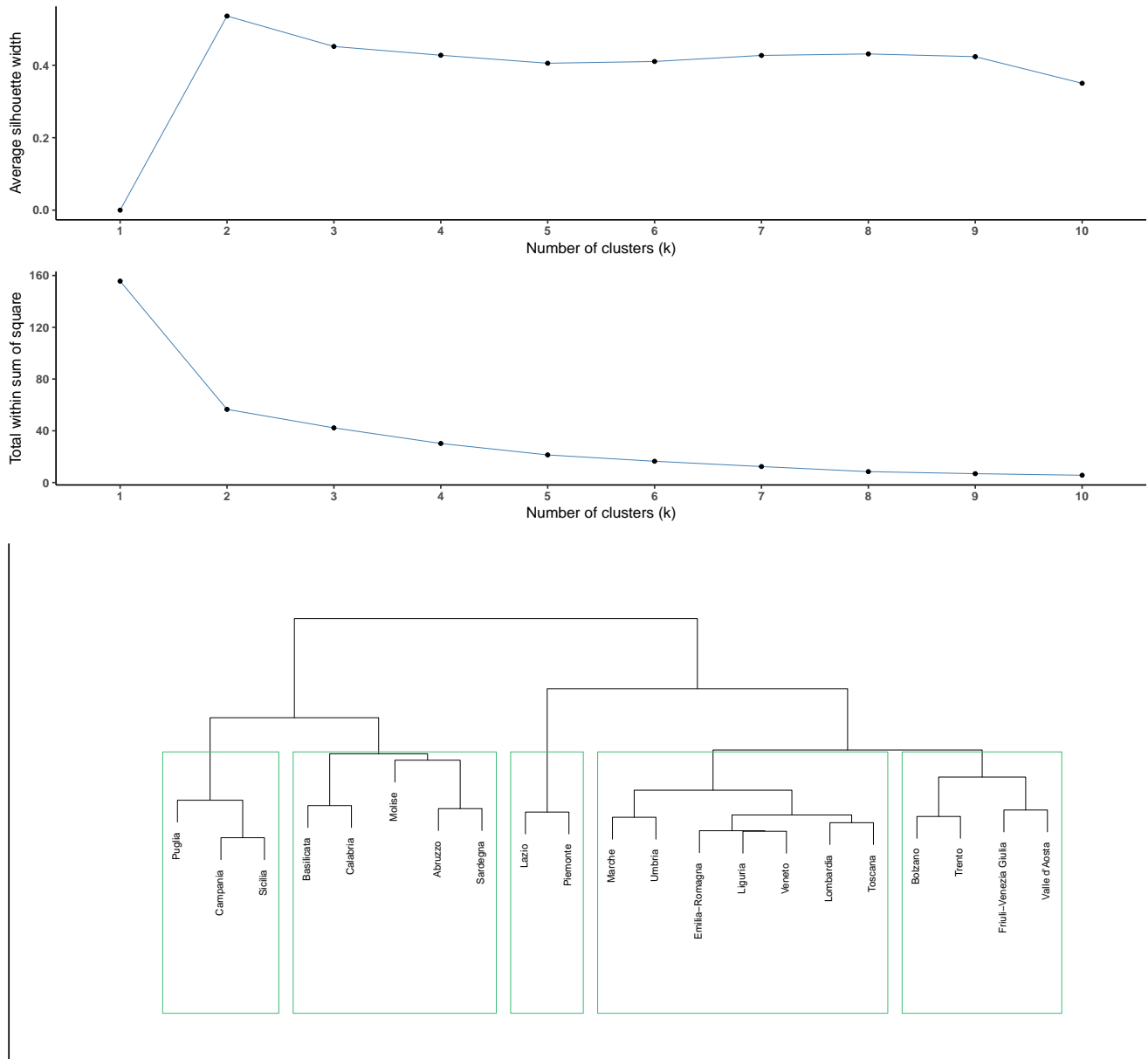


Figure 11: Clustering diagnostics: Silhouette plot (*Top*), Elbow plot (*Middle*), Dendrogram (*Bottom*).

Figure 11 displays three diagnostics: the silhouette plot (*top*), elbow plot (*middle*), and dendrogram (*bottom*). The silhouette method favours a two-cluster solution, capturing the most basic division in the data.

However, the elbow plot and dendrogram suggest a more nuanced structure. In particular, the elbow plot shows that within-cluster variance declines markedly up to $k = 5$, after which improvements flatten. The dendrogram further supports a clear and interpretable five-cluster configuration.

We therefore adopt the five-cluster solution as the best compromise between parsimony and explanatory depth, revealing meaningful regional profiles that would be obscured by a simpler classification.

Appendix F Formal investigation of the well-being/gender equality nexus via Canonical Correlation Analysis (CCA)

While the main analysis identifies regional typologies using PCA-based clustering, here we formally test the multivariate relationship between the five well-being and five gender equality macrodomains through Canonical Correlation Analysis (CCA) (see [Hotelling, 1936](#); [Härdle and Simar, 2015](#), for details). Unlike PCA, which reduces a single dataset, CCA uncovers the strongest linear associations between two variable sets. It identifies pairs of canonical variates—linear combinations from the well-being set (V) and the gender equality set (U)—that are maximally correlated. This provides a robustness check, assessing both the strength and dimensionality of the relationship between well-being and gender equality.

Table 12 reports two statistically significant canonical functions. The first (CV1) shows a very strong correlation ($R = 0.93^{***}$), while the second (CV2) remains substantial ($R = 0.81^*$), indicating a secondary but relevant axis of association.

Table 12: Canonical correlations and significance levels.

Variate	Canonical correlation	Shared variance	p-value
CV1	0.929	0.826	<0.01
CV2	0.806	0.649	<0.10
CV3	0.626	0.392	> 0.10
CV4	0.275	0.076	> 0.10
CV5	0.088	0.008	> 0.10

Note: p-values from Bartlett's test of significance.

CV1 reflects a "Synergy" dimension, where high tangible well-being (education, economy, health, societal) aligns with strong gender equality in human development and societal domains. Signs were reversed for interpretive clarity. CV2 captures a "Trade-off" dimension, linking high overall well-being with mixed equality profiles—strong in societal and health domains but weak in economic and subjective aspects (Table 13).

Table 13: Structural correlations (loadings) for the significant canonical variates.

Variable	CV1 (Synergy)	CV2 (Trade-off)
<i>Equality (X) set</i>		
Education	+0.87	+0.07
Societal	+0.77	+0.55
Health	+0.66	+0.35
Quality of life	+0.59	-0.79
Economy	-0.15	-0.47
<i>Well-being (Y) set</i>		
Education	+0.57	+0.73
Economy	+0.54	+0.81
Health	+0.44	+0.84
Societal	+0.40	+0.87
Quality of life	-0.11	+0.95

Figure 12 plots regional scores on CV1, confirming the five-cluster typology: Southern regions (Clusters 1 and 3) occupy the bottom-left quadrant, while high-performing regions cluster top-right. Lazio and Piemonte exemplify positive synergy, whereas Valle d'Aosta diverges from this pattern.

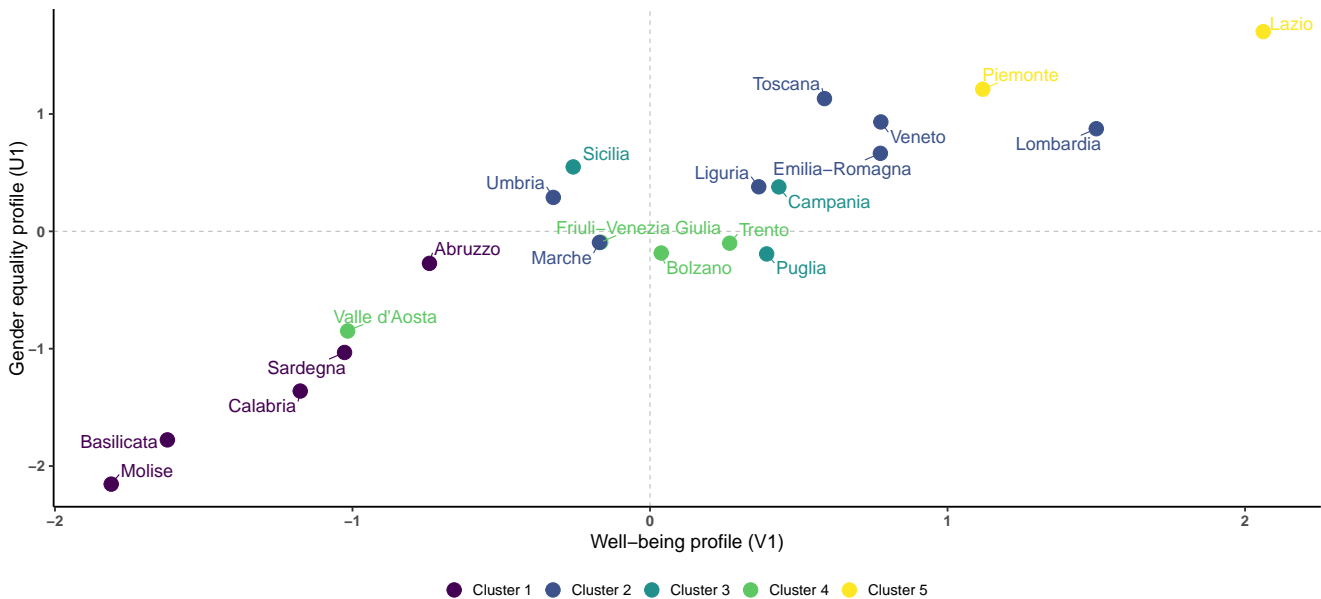


Figure 12: Regional profile on the dominant CCA dimension (CV1).

Figure 13 ranks regions on CV2, highlighting those with strong societal and health equality but weak

economic and subjective parity—such as Trento, Bolzano, and Valle d’Aosta. Conversely, Campania, Piemonte, and Lazio show more balanced profiles.

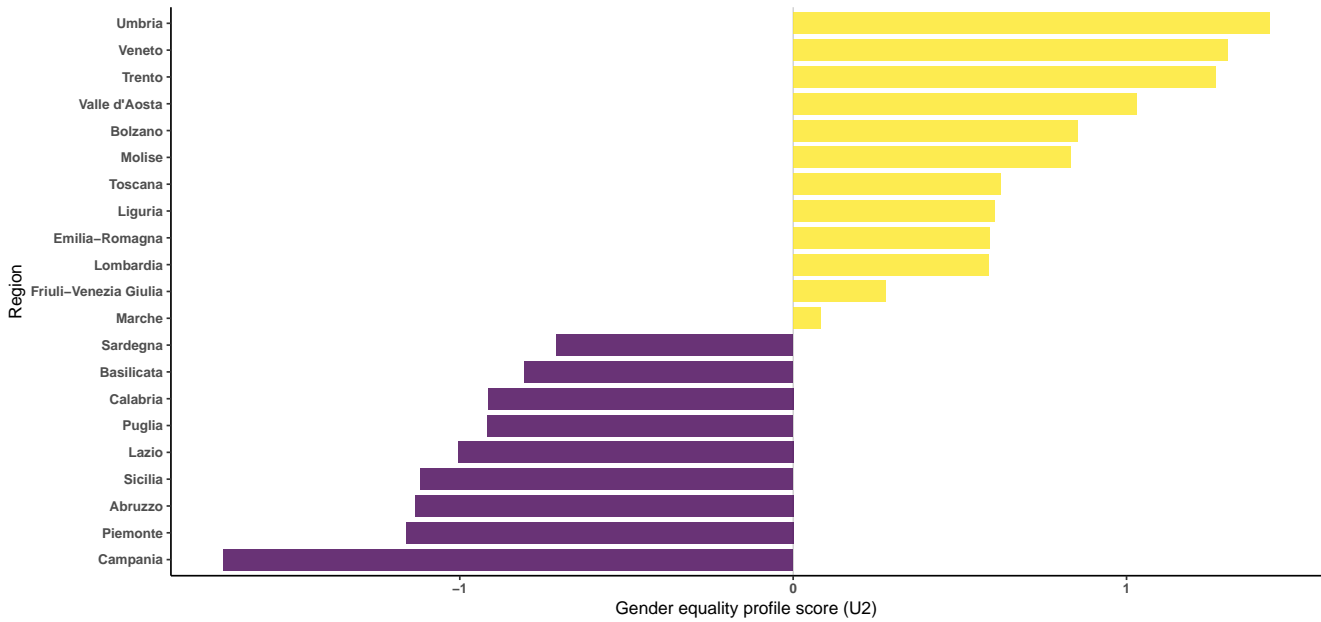


Figure 13: Regional profile on the second CCA equality dimension (U2). *Notes:* higher scores reflect stronger societal and health gender equality but lower economic and subjective equity.

Together, these results reinforce the main conclusion: well-being and gender equality are deeply interlinked but not uniformly so. CCA validates the clustering structure and reveals policy-relevant trade-offs, confirming that Italian regions follow distinct developmental pathways shaped by both synergies and tensions.

Appendix G Convergence analysis: methodology

We assess regional convergence using three complementary approaches. *β -convergence*. This tests whether initially less-developed regions grow faster than advanced ones, implying convergence toward a common steady state. The hypothesis is estimated via:

$$\log\left(\frac{y_{j,i,t}}{y_{j,i,t_0}}\right) = \alpha_j + \beta_j \log(y_{j,i,t_0}) + \varepsilon_{j,i} \quad (2)$$

where $y_{j,i,t}$ is the indicator for macrodomain j , region i at time t , y_{j,i,t_0} is its value in the initial period and $\varepsilon_{j,i}$ is the error term. A negative, significant β_j , which measures the speed of convergence, indicates catch-up dynamics.

σ -convergence. This examines whether cross-sectional dispersion declines over time, measured by the coefficient of variation $CV_{j,t}$ within each macrodomain j across regions. The hypothesis is tested via:

$$CV_{j,t} = \alpha_j + \beta_j Trend_j + \varepsilon_{j,t} \quad (3)$$

where $CV_{j,t}$ is the coefficient of variation within macrodomain j at time t , $Trend_j$ is a time trend for macrodomain j and $\varepsilon_{j,t}$ is the error term. A negative, significant β_j signals decreasing dispersion (convergence), while non-negative values imply persistent or widening gaps.²²

γ -convergence. This non-parametric approach evaluates rank mobility using Kendall's index of concordance. Following (Chelli et al., 2023), we adopt a binary version of the test:

$$\gamma_j = \frac{\text{var}(R_{j,i,t} + R_{j,i,t_0})}{\text{var}(2 \cdot R_{j,i,t_0})} \quad (4)$$

where $R_{j,i,t}$ denotes the rank for macrodomain j of region i at time t in the cross-sectional distribution, and R_{j,i,t_0} is its rank in the initial period. Values near 0 indicate strong mobility (high re-ranking), while values near 1 reflect persistent inequality.

²²The coefficient of variation is the ratio of the standard deviation to the mean; in some cases, the standard deviation alone is used.

Appendix H Detailed temporal trends by macrodomain (2018-2023)

The breakdown of well-being indicators confirms a pattern of widespread improvement across most regions and macrodomains (Figure 14).

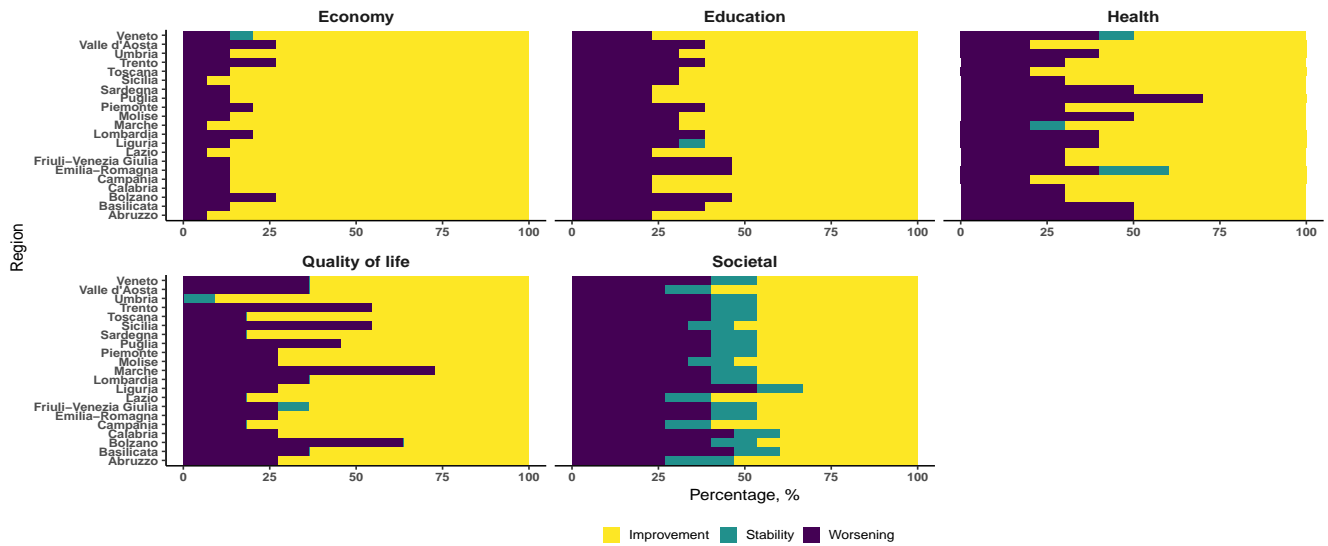


Figure 14: Temporal evolution of well-being indicators (64) by macrodomain (2018-2023).

By contrast, gender equality indicators reveal a more heterogeneous and overall negative trend, with notable disparities across macrodomains (Figure 15).

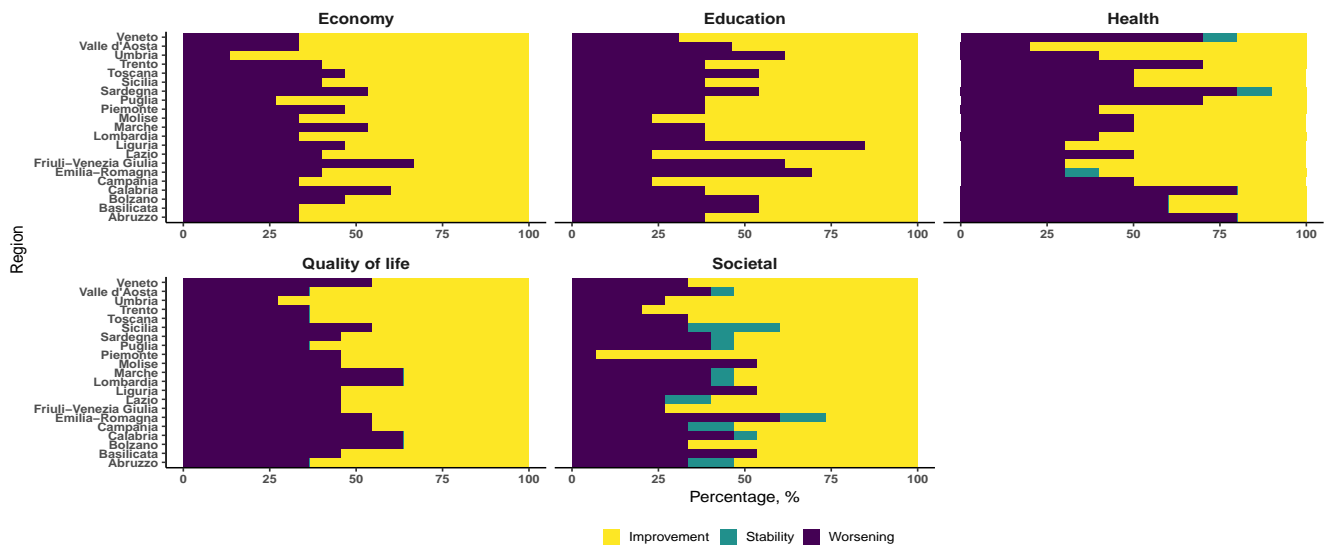


Figure 15: Temporal evolution of gender equality indicators (64) by macrodomain (2018-2023).

Appendix I Robustness checks for convergence analysis

We assess the sensitivity of convergence estimates using two diagnostics: a *leave-one-region-out* jackknife procedure for $\hat{\beta}$ and $\hat{\sigma}$; and Cook's distance to detect influential observations. Figures 16-17 show jackknife distributions by macrodomain and dimension, with vertical lines marking full-sample estimates. The narrow dispersion indicates that results are not driven by single-region exclusions.

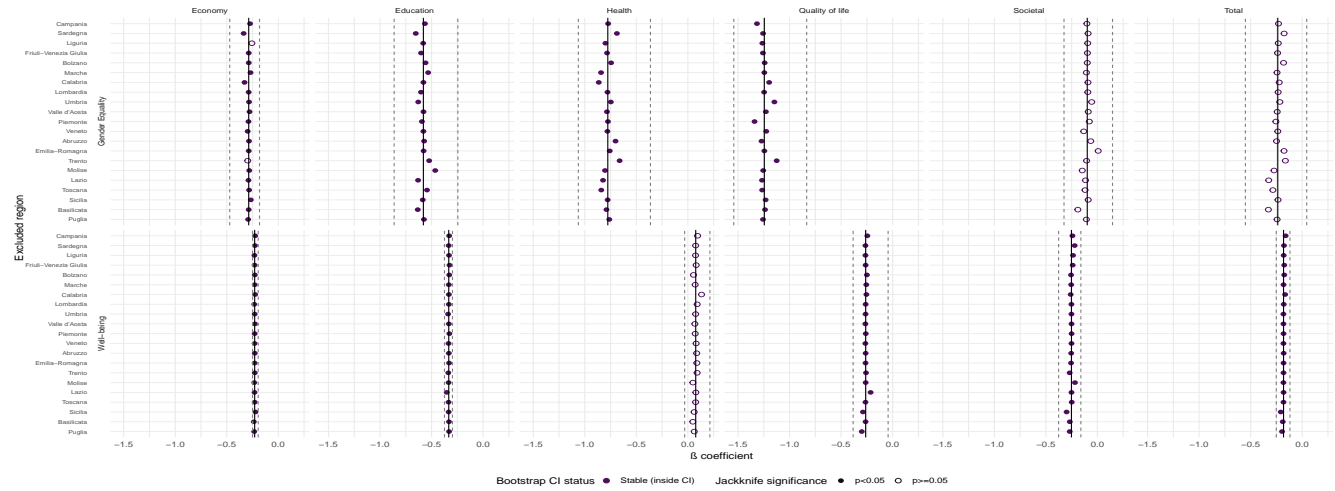


Figure 16: Jackknife estimates of β coefficient by macrodomain and dimension.
 Notes: Each point reports the $\hat{\beta}^{(-i)}$ coefficient estimated when region i is excluded, grouped by macrodomain and dimension. Vertical lines denote the full-sample estimates.

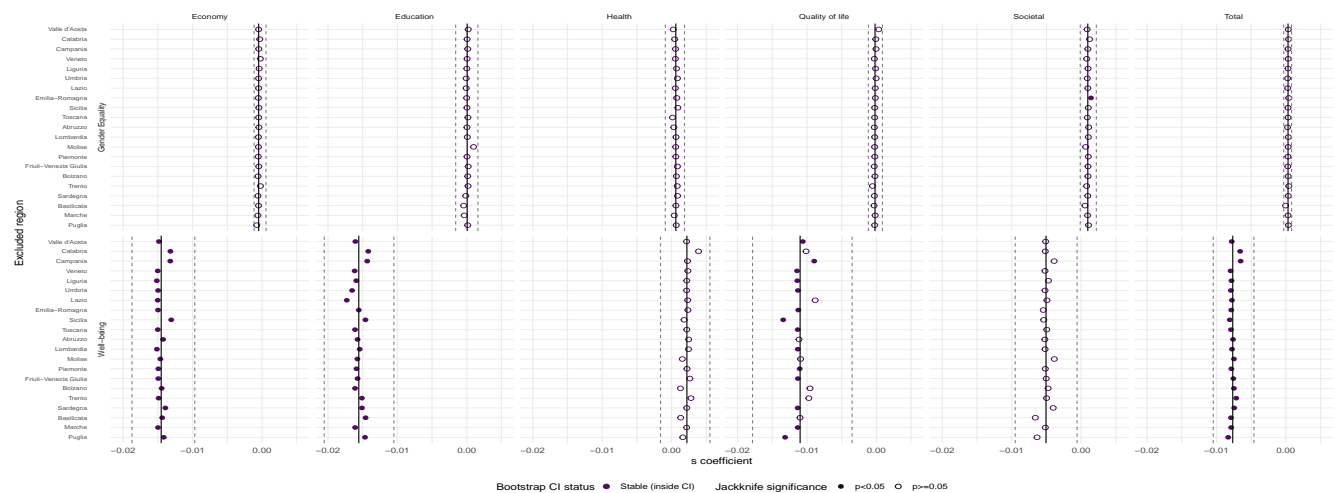


Figure 17: Jackknife estimates of σ coefficient by macrodomain and dimension.
 Notes: Each point reports the $\hat{\sigma}^{(-i)}$ coefficient estimated when region i is excluded, grouped by macrodomain and dimension. Vertical lines denote the full-sample estimates.

Table 14 summarizes full-sample estimates, jackknife ranges, and the share of significant replications. Most macrodomains exhibit tight ranges and high significance consistency, supporting robustness.

Table 14: Jackknife summary: β and σ (leave-one-region-out)

Type	macrodomain	$\hat{\beta}$ (full)	Range [$\beta_{\min}, \beta_{\max}$]	Share (p<0.05)	$\hat{\sigma}$ (full)	Range [$\sigma_{\min}, \sigma_{\max}$]	Share (p<0.05)
Gender Equality	Economy	-0.287	[-0.336, -0.257]	0.90	-0.0005	[-0.0008, -0.0002]	0.00
	Education	-0.579	[-0.653, -0.464]	1.00	0.0001	[-0.0005, 0.0010]	0.00
	Health	-0.777	[-0.864, -0.662]	1.00	0.0006	[0.0001, 0.0009]	0.00
	Quality of life	-1.250	[-1.340, -1.125]	1.00	-0.0002	[-0.0006, 0.0003]	0.00
	Societal	-0.099	[-0.190, 0.008]	0.00	0.0010	[0.0006, 0.0014]	0.05
	Overall	-0.237	[-0.328, -0.163]	0.00	0.0003	[0.0000, 0.0004]	0.00
Well-being	Economy	-0.229	[-0.238, -0.221]	1.00	-0.0145	[-0.0152, -0.0131]	1.00
	Education	-0.333	[-0.353, -0.326]	1.00	-0.0156	[-0.0173, -0.0142]	1.00
	Health	0.076	[0.048, 0.133]	0.00	0.0022	[0.0013, 0.0039]	0.00
	Quality of life	-0.262	[-0.299, -0.214]	1.00	-0.0110	[-0.0134, -0.0088]	0.67
	Societal	-0.252	[-0.299, -0.218]	1.00	-0.0051	[-0.0066, -0.0039]	0.00
	Overall	-0.181	[-0.207, -0.161]	1.00	-0.0077	[-0.0083, -0.0065]	1.00

Notes: Each row reports the full-sample estimate, the leave-one-region-out min/max range, and the share of jackknife replications significant at $p < 0.05$ for both β and σ coefficients.

Finally, Table 15 reports maximum Cook's distances by macrodomain. All values are well below the conventional threshold ($D < 1$), confirming that no domain exerts disproportionate influence. The slightly higher value for the overall well-being index suggests greater cross-domain sensitivity, though still acceptable.

Table 15: Maximum Cook's distance by macrodomain.

Macrodomain	Well-being	Gender equality
Economy	0.246	0.173
Education	0.269	0.227
Health	0.409	0.155
Quality of life	0.317	0.310
Societal	0.357	0.209
Overall	0.611	0.267

Overall, these checks confirm that convergence patterns are stable across specifications and resilient to outliers.